Clean Water Act
§ 316(b) Compliance
Submittal Requirements

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American Electric Power

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July 20, 2015

Clinch River Plant
Carbo, VA

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Executive Summary

This report addresses requirements of the Clean Water Act's Section 316(b) existing facilities rule for American Electric Power's (AEP's) Clinch River Plant. For affected facilities[1], the rule defines national standards for the location, design, construction, and capacity of cooling water intake structures (CWIS) to be implemented under the National Pollutant Discharge Elimination System (NPDES) permit program. The existing facilities rule calls for the submission of several reports under 40 CFR 122.21(r) – Application for a permit renewal. This document represents those submittals for AEP's Clinch River Plant (i.e., those defined at 40 CFR 122.21(r)(2)-(8) for facilities with Actual Intake Flow (AIF) less than 125 MGD). This report examines the Clinch River Plant's Cooling Water Intake Structure (CWIS) relative to the rule's standards for Best Technology Available (BTA).

The Clinch River Plant is located near Carbo, Virginia on the Clinch River at River Mile 268. The facility and its cooling water system are intended for year-round, 24 hours/day operation, with the exception of down time due to outages. The facility has a single CWIS that serves its two generating units. Historically, there were three generating units, but Unit 3 has been retired since May 2015. The CWIS has two conventional traveling water screens. Three pumps, each rated at 6,500 gallons per minute (GPM), provide flows to the two units. Normal water needs can be met with only one pump while the second and third pumps are held in standby mode, resulting in a design intake flow of 9.36 million gallons per day (MGD). Approximately 65% of the design intake flow is used for cooling purposes. The Clinch River Plant utilizes mechanical draft (5-cell counter-flow) cooling towers on a closed loop system. Water is recycled and reused in the steam turbine condensers.

There are several features of the design and operation of Clinch River Plant's CWIS and cooling water system that reduce losses of aquatic organisms due to impingement and entrainment. The combination of the technological and operational features used at Clinch River Plant should be considered BTA for both entrainment and impingement. In particular, several steps, as outlined below, have been undertaken to reduce water use at the facility.

Key Findings of No Adverse Environmental Impact:

- Clinch River uses a closed-cycle cooling system. The towers are presently operating at two-to-five cycles of concentration and provide a flow reduction of at least 97.0% compared to a once-through system. Since reductions in impingement and entrainment can be assumed to be commensurate with reductions in flow, use of closed-cycle cooling at Clinch River Plant is assumed to reduce potential impingement and

[1] Facilities affected by the rule are those that: 1) commenced construction on or before January 17, 2002; 2) withdraw at least two million gallons per day from waters of the United States; 3) use at least 25% of that water exclusively for cooling purposes; and 4) are regulated under the NPDES program.

entrainment by at least 97.0%. Use of closed-cycle cooling meets the impingement mortality reduction standard through Compliance Alternative 1 (§125.94(c)(1)).

- Current design withdrawal from the Clinch River by the river intake is 6,500 GPM (9.36 MGD) with a maximum design through-screen velocity of 0.5 fps.

- Clinch River Plant has a favorable orientation of the intake in terms of potential reduction in impingement and entrainment because of (1) perpendicular orientation of the intake to river currents such that passive organisms would tend to be carried past the intake and (2) intake location in the midsection of a long pool, which physically isolates it from the majority of fish and mussel species that tend to inhabit riffle/run habitat (in particular the T&E species).

- State- and Federally-protected fish and mussel species are listed as occurring in the vicinity of the Clinch River plant. Protected mussel species are the subject of a re-introduction program in the relevant river reach. Low susceptibility to impingement and entrainment of listed species due to life history and occurrence considerations, combined with minimal intake area of influence and low through-screen velocities at Clinch River Plant result in negligible potential for impact or take.

For the reasons outlined above and consistent with the Section 316(b) existing facilities rule, AEP's Clinch River Plant utilizes BTA to reduce impingement and entrainment losses and minimize adverse environmental impact. Therefore, no additional control measures to reduce impingement and entrainment mortality are expected to be necessary.

1 Regulatory Background

Clean Water Act §316(b) was enacted under the 1972 Clean Water Act, which also introduced the National Pollutant Discharge Elimination System (NPDES) permit program. Facilities with NPDES permits are subject to §316(b), which requires that the location, design, construction and capacity of cooling water intake structures (CWIS) reflect best technology available (BTA) for minimizing adverse environmental impacts. Cooling water intakes can cause adverse environmental impacts by drawing early life-stage fish and shellfish into and through cooling water systems (entrainment), or trapping juvenile or adult fish against the screens at the opening of an intake structure (impingement).

On August 15, 2014, the final §316(b) rule (final rule) for existing facilities was published in the Federal Register. The rule applies to existing facilities that withdraw more than 2 million gallons per day (MGD) from Waters of the United States, use at least 25 percent of that water exclusively for cooling purposes, and have or require an NPDES permit. The rule supersedes the Phase II rule, which regulated existing electrical generating facilities until it was remanded in 2007. (The final rule also replaces the remanded existing-facility portion of the previously promulgated Phase III rule) The final rule became effective on October 14, 2014.

Facilities subject to the final rule are required to develop and submit technical material, identified at §122.21(r)(2)-(13), that will be used by the NPDES Director (Director) to make a BTA determination for the facility. The actual intake flow (AIF) and design intake flow (DIF) at a facility determine what submittals will be required. As shown in Table 1-1, facilities with AIF rates of 125 MGD and less have fewer application submittal requirements and will generally be required to select from the impingement compliance options contained in the rule. For such facilities, the Director must still determine BTA for entrainment on a site-specific basis and the applicant may supply information relevant to the Director's decision. Facilities with AIF in excess of 125 MGD are required to address both impingement and entrainment and provide specific entrainment studies which may involve extensive field studies and analysis of alternatives to reduce entrainment (§122.21(r)(9)-(13)). Facilities equipped with closed-cycle recirculating systems are not automatically exempt from these requirements.

Table 1-1. Facility Flow Attributes and Permit Application Requirements

Facility Flow Attributes	Applicable Requirements
Existing facility w/ DIF > 2 MGD and AIF > 125 MGD	§122.21(r)(2)-(13) Includes impingement mortality standard and site-specific entrainment requirements with additional entrainment study and reporting requirements
Existing facility w/ DIF > 2 MGD and AIF < 125 MGD	§122.21(r)(2)-(8) Includes impingement mortality standard and site-specific entrainment requirements; additional reports for entrainment at Director discretion
2 MGD or less DIF or < 25% of AIF used for cooling purposes	Director BPJ

The compliance schedule is dependent on the facility's NPDES permit renewal date. Facilities are to submit their §316(b) application material to their Director along with their next permit renewal, unless that permit renewal takes place prior to July 14, 2018, in which case an alternate schedule may be requested.

American Electric Power (AEP)'s Clinch River Plant is subject to the existing facility rule and based on its current configuration and operation is anticipated to be required to develop and submit each of the §122.21(r)(2)-(8) submittal requirements (Table 1-2) with its next permit renewal in accordance with the rule's technical and schedule requirements.

Table 1-2. Summary of §316(b) Rule for Existing Facilities Submittal Requirements for §122.21(r)(2)-(8)

Submittal Requirements at §122.21(r)		Submittal Descriptions
(2)	Source Water Physical Data	Characterization of the source water body including intake area of influence
(3)	Cooling Water Intake Structure Data	Characterization of cooling water system; includes drawings and narrative; description of operation; water balance
(4)	Source Water Baseline Biological Characterization data	Characterization of biological community in the vicinity of the intake; life history summaries; susceptibility to impingement and entrainment; must include existing data; identification of missing data; threatened and endangered species and designated critical habitat summary for action area; identifies fragile fish and shellfish species list (<30 percent impingement survival)
(5)	Cooling Water System Data	Narrative description of cooling water system and intake structure; proportion of design flow used; water reuse summary; proportion of source water body withdrawn (monthly); seasonal operation summary; existing impingement mortality and entrainment reduction measures; flow/MW efficiency
(6)	Chosen Method of Compliance with Impingement Mortality Standard	Provides facility's proposed approach to meet the impingement mortality requirement (chosen from seven available options); provides detailed study plan for monitoring compliance, if required by selected compliance option; addresses entrapment where required
(7)	Entrainment Performance Studies	Provides a summary of relevant entrainment mortality studies (latent mortality, technology efficacy); can be from the facility or elsewhere with justification; studies should not be more than 10 years old without justification; new studies are not required
(8)	Operational Status	Provides operational status for each unit; age and capacity utilizations for the past five years; upgrades within last 15 years; uprates and Nuclear Regulatory Committee relicensing status for nuclear facilities; decommissioning and replacement plans; current and future operation as it relates to actual and design intake flow

2 Source Water Physical Data [§122.21(r)(2)]

2.1 Description of Source Water Body [§122.21(r)(2)(i)]

The Clinch River Plant is located near Carbo, Virginia on the Clinch River at River Mile 268.0. The USGS Topographic elevation map showing the vicinity of the plant is provided in Figure 2-1. The Clinch River arises in southwest Virginia, flowing into Tennessee and joining with the Powell River before entering the Tennessee River. The Virginia waters of the Clinch River lie within the steep-sloped Ridge and Valley and Cumberland Plateau physiographic provinces of the central Appalachian Mountains. The average gradient of the upper, free-flowing portion of the river covering 188 miles from its source near Tazewell, Virginia, to Norris Reservoir in Tennessee is 9.3 ft/mi (Masnik 1974). The river is characterized by extensive pool-riffle development, including several islands and braided channel segments. The geology of the region is dominated by exposed limestone and dolomite formations, which produce a carbonate-rich system with pH in the range of 7.5-8.5 (Masnik 1974). There is no scaled drawing for salinity and the parameter is not believed to be relevant due to the plant being located on a freshwater river.

The upper Clinch River near the facility has a drainage area of approximately 533 sq. mi. (Krstolic et al. 2013). Land use is about two-thirds forestland, with most of the remainder utilized as grazing land. Urban, industrial, and mining uses combine for less than ten percent of land use (Van Hassel 2007). For the segment of the Clinch River that includes the plant intake and ten miles upstream, water quality was supportive of all uses except recreation, which was impaired by *E. coli* bacteria (VDEQ/VDCR 2014).

Water temperatures in the Clinch River at river mile 271.6, 3.6 miles upstream of the plant intake, ranged from means of 38.2°F in January to 76.0°F in July for the years 2010-2014 (see Table 2-1 below). There is no scaled drawing for water temperatures available. The data presented in Table 2-1 characterize the Clinch River thermal regime at the plant intake. This section of the Clinch River is characterized by well-defined pools and riffles, and is well mixed such that thermal stratification or zones are not typical.

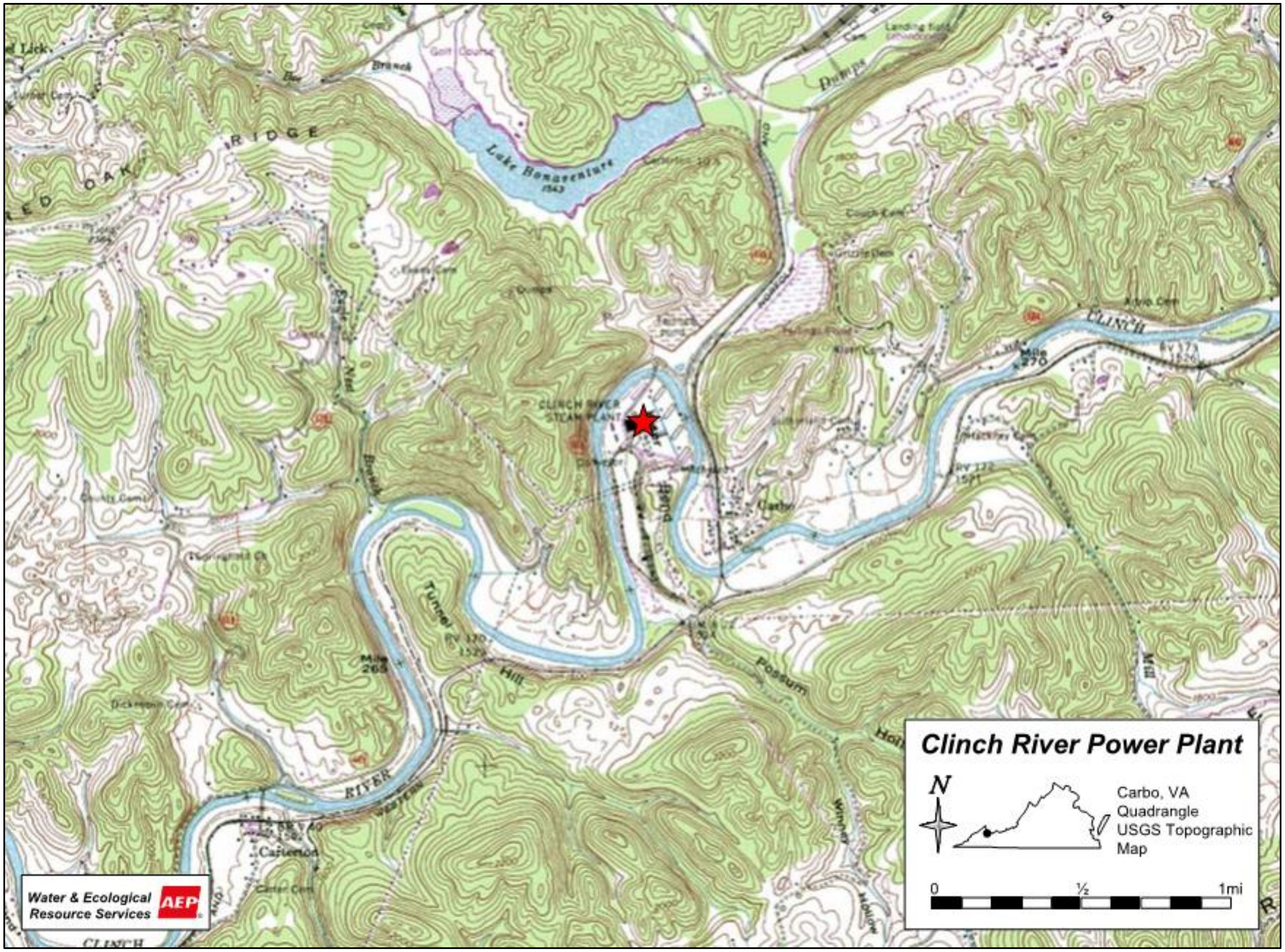


Figure 2-1. Locational Map of Clinch River Plant

Table 2-1. Clinch River Water Temperature near the Clinch River Plant (°F)

Month	2010	2011	2012	2013	2014	Mean
January	38.0	36.7	42.3	42.6	31.6	38.2
February	39.5	42.7	44.7	42.6	32.7	40.4
March	45.8	49.5	54.9	44.2	51.1	49.1
April	59.3	57.3	57.8	55.4	58.1	57.6
May	65.2	62.1	67.7	63.0	66.4	64.9
June	74.0	73.9	72.9	72.1	75.2	73.6
July	78.3	77.6	76.3	73.8	73.9	76.0
August	75.3	76.5	73.6	71.2	73.2	74.0
September	70.7	68.5	67.8	68.2	69.0	68.8
October	57.9	57.1	56.5	61.0	--	58.1
November	47.9	49.2	43.5	53.6	--	48.6
December	37.1	45.5	43.7	51.1	--	44.4

2.2 Characterization of Source Water Body [§122.21(r)(2)(ii)]

2.2.1 Hydrology

River flow data were obtained from the U.S. Geological Survey (USGS) gage at Cleveland, Virginia, located 3.6 miles upstream of the plant. For the data record from 1921 to 2015, monthly mean flows were lowest in September, with a mean of 220 ft^3/sec (cfs), and highest in March, with a mean of 1,407 cfs. Tables 2-2 and 2-3 present monthly minimum, maximum and average flows and summary statistics of Clinch River flows at the USGS Cleveland, VA station (River Mile 271.6), respectively. Drought conditions, defined as flows below a 7Q10 of 56 cfs, are rare outside of the September to October time frame and are typically of a short duration (e.g., < 10 days).

2.2.2 Geomorphology

The Tennessee River drainage, including the Clinch River, is the largest tributary of the Ohio River basin, and contains the most diverse ichthyofauna in North America. In Virginia, the drainage is almost entirely in the Valley and Ridge Province, and is unique in the state for characteristic large shoals composed mainly of loose gravel (Jenkins and Burkhead 1994). Another feature contributing to the faunal diversity is the lack of a major impoundment in the Virginia portion of these rivers, which have retained their strong pool-riffle configuration.

Table 2-2. Clinch River Stream Flow (cfs) at River Mile 271.6

Month	Monthly Mean Flow (cfs)	Monthly Maximum		Monthly Minimum	
		Flow (cfs)	Water Year* (WY)	Flow (cfs)	WY
Jan	1,116	2,817	1937	92	1940
Feb	1,330	3,360	1957	206	1941
Mar	1,407	4,572	1955	309	1988
Apr	1,052	3,414	1987	228	1942
May	790	2,254	1958	195	1941
Jun	495	2,353	2004	80	1930
Jul	342	1,292	2001	78	1930
Aug	323	1,640	1940	63	1988
Sep	220	1,003	1989	55	1930
Oct	264	1,389	1977	54	1931
Nov	417	2,011	1978	64	1940
Dec	793	3,043	1927	81	1940

Note: *The term "water year" in reports that deal with surface-water supply is defined as the 12-month period October 1, for any given year through September 30, of the following year. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months.

Table 2-3. Summary Statistics of Clinch River flows at the USGS Cleveland, VA Station

Statistic	WY 2014		WY 1921 - 2015	
Annual mean (cfs)	631.9		708.5	
Highest annual mean (cfs)			1,128	WY 2004
Lowest annual mean (cfs)			287.4	WY 1988
Highest daily mean (cfs)	4,490	Dec 30, 2013	27,800	Apr 05, 1977
Lowest daily mean (cfs)	108.0	Nov 14, 2013	37.0	Sep 13, 1964
Annual 7-day minimum (cfs)*	113.1	Nov 11, 2013	39.6	Sep 13, 1964
Maximum peak flow (cfs)	5,750	Feb 03, 2014	34,500	Apr 05, 1977
Maximum peak stage (ft)	8.66	Feb 03, 2014	26.4	Apr 05, 1977
Annual runoff (cfsm)	1.19		1.33	
Annual runoff (inches)	16.1		18.1	
10 percent exceeds (cfs)	1,368		1,560	
50 percent exceeds (cfs)	407.0		383.0	
90 percent exceeds (cfs)	134.0		98.0	

Data Source: Water Data Report 2014 of USGS Gaging Station #03524000 Clinch River at Cleveland, VA
Note: *Annual 7-day minimum flow is the lowest mean discharge for 7 consecutive days during a water year. The date shown in the summary statistics table is the initial date of the 7-day period.

In the plant vicinity, the Clinch River varies from approximately 75-120 feet in width, and the Clinch River Plant's CWIS is located at the center of a deep pool approximately 900 feet long with depth of approximately 10 feet around the intake. No scaled drawing of water depth is available. Substrate composition is dominated by the sand/gravel/rubble fractions. Measurements near the facility found percentages by volume of 32-46% rubble, 19-25% gravel, and 31-39% sand, with typically 0-5% boulder and silt (Van Hassel 2007). The sediment movement in the river is dynamic, with scour and deposition changing with changing flow conditions. There has been no excessive deposition in the immediate vicinity of the plant intake structure.

2.2.3 Determination of Area of Influence

The "area of influence" (AOI) of a CWIS appears in three of the §122.21(r) sections of the §316(b) final rules for existing facilities:

- §122.21(r)(2) Source Water Physical Data requires information on "the methods used to conduct any physical studies to determine the intake's ***area of influence*** in the waterbody and the results of such studies."
- §122.21(r)(4) Source Water Baseline Biological Characterization Data says: "The study area should include, at a minimum, the ***area of influence*** of the cooling water intake structure."
- §122.21(r)(11) Benefits Valuation Study says: "The study would also include discussion of recent mitigation efforts already completed and how these have affected fish abundance and ecosystem viability in the intake structure's ***area of influence***."

Although the final rule does not provide a definition of AOI, the §316(b) Phase I rule for new facilities states that:

> *"The area of influence is the portion of water subject to the forces of the intake structure such that a particle within the area is likely to be pulled into the intake structure."*

While neither a formal definition of the AOI nor guidance for its estimation is provided within §316(b) final rule for existing facilities, it is commonly assumed that the AOI is that area of the source waterbody directly affected by the CWIS. Relative to impingeable organisms, generally juvenile and adult fish and shellfish, the concept is somewhat more concrete. It could be assumed that it is the point at which the organism is no longer capable of overcoming the forces of water withdrawal and impinges upon an intake screen (EPRI 2007). This would be highly dependent on the swimming capabilities of the species, its life stage, size, and general health condition; a point noted by EPRI in previous research on the relationship between intake approach velocity and the occurrence of impingement (EPRI 2000).

EPA considers 0.5 ft/s (fps) to be a *de minimis* value for the probability of impingement and this can be interpreted to mean that a fish can swim freely in a flow at this velocity and avoid impingement. As a compliance option for impingement in the 316(b) final rule for existing facilities, EPA indicates that there is no need for any type of impingement protection including impingement mortality studies if the maximum design or actual maximum through-screen velocity of the CWIS is 0.5 fps or less. Under these conditions, it is considered that the facility has met the performance standards for impingement mortality. Therefore, it can be interpreted that the 0.5 fps contour for velocities induced by the CWIS delineates the CWIS's AOI for impingement. This approach, in fact, was proposed to Ohio EPA (OEPA) by Dayton Power & Light (DPL) in their Proposal for Information Collection (PIC) for their Stuart Generating Station on the Ohio River. Their approach was accepted by OEPA and also recommended as a model for other facilities on the Ohio River (EPRI 2007).

Relative to entrainable organisms that have limited to no swimming capabilities and which are passively transported by water currents, a velocity threshold for entrainment, similar to the 0.5 fps velocity contour for impingement AOI, is not deemed a good approach because a passive particle in water may be drawn into the intake regardless of the magnitude of intake induced velocities. Therefore, our discussion on entrainment AOI will be focused on the volume of water withdrawn compared to the source water body and percent flow reduction achieved by the chosen compliance option compared to a once-through cooling system.

Methods

As stated above, the impingement AOI is the approximate area within the 0.5 fps velocity contour in the vicinity of CWIS and a simple desktop analysis is used for the following analysis.

Desktop calculations of the AOI of a cooling water intake are based on the principles of conservation of mass and continuity and require simplifying assumptions such as average water depth. A low water elevation and zero ambient velocity would provide a conservative estimate of AOI. Below are shown the calculation steps for estimating the AOI. By definition, Area of Influence (AOI) or Hydraulic Zone of Influence (HZI) is the location where the velocity induced by the intake is equal to a specified threshold velocity. In the case of impingement, and as discussed above, that threshold velocity is assumed to be 0.5 fps. The radius of AOI (R_{AOI}) for an arc angle of 180 degrees (i.e., a shoreline intake structure) can be estimated from a continuity equation:

$$Qi = \pi \times R_{AOI} \times d \times V \qquad \text{Eq. 1}$$

where, Q_i = Intake Flow
R_{AOI} = Radius of Area of Influence
d = Water depth at R_{AOI}
V = Threshold velocity (i.e., 0.5 fps for impingement AOI).

Rearranging terms in equation 1 gives:

$$R_{AOI} = Qi /(\pi \times d \times V) \qquad \text{Eq. 2}$$

As noted above the entrainment AOI will be evaluated based on comparison of the intake flow to the Clinch River flow.

Results

Using a low water depth at the intake of 4 ft (as a conservative assumption) and 6,500 GPM (9.36 MGD) rated capacity of the river water make-up pump, the calculated radius of the AOI using the equation 2 above is 2.3 ft.

The plant design intake withdrawal (9.36 MGD) during low-flow conditions in the March-July peak larval density period is estimated at 2.6-13.1% of the low river flows (95% exceedance flows) and 1.0-4.2% of mean monthly flows. Additionally, the water withdrawn is not totally consumed by the plant, i.e., approximately one third of the water withdrawn is returned to the river, resulting in less than 15% of the river being consumed during critical low flow events based on the lowest 95% exceedance flow in October (see Table 5-1 in Section 5.1). This withdrawal should not impact downstream aquatic life, recreation, water supply, and other water uses. Also, the perpendicular orientation of the intake structure to river current, and less than 0.5 fps through-screen velocities, reduces adverse impacts such that passive organisms will tend to be carried past the intake.

In summary, the AOI at Clinch River Plant is considered insignificant for impingement due to the fact that the area over which the intake-induced velocity is greater than 0.5 fps, the threshold value for impingement, has a radius of 2.3 ft. Additionally, based on the magnitude of the intake flow relative to the river flow, the AOI for entrainment (i.e., the volume of river in which entrainment probability is high) would be small.

2.3 Locational Maps [§122.21(r)(iii)]

The locational map is provided in Figure 2-1 (under Section 2.1) which is the USGS topographic map showing the area near Clinch River Plant. Also, Figure 2-2 below presents an annotated aerial photo of the Plant and its environs.

Map source: Google earth

Figure 2-2. Aerial Photo of Clinch River Plant

3 Cooling Water Intake Structure Data [§122.21(r)(3)]

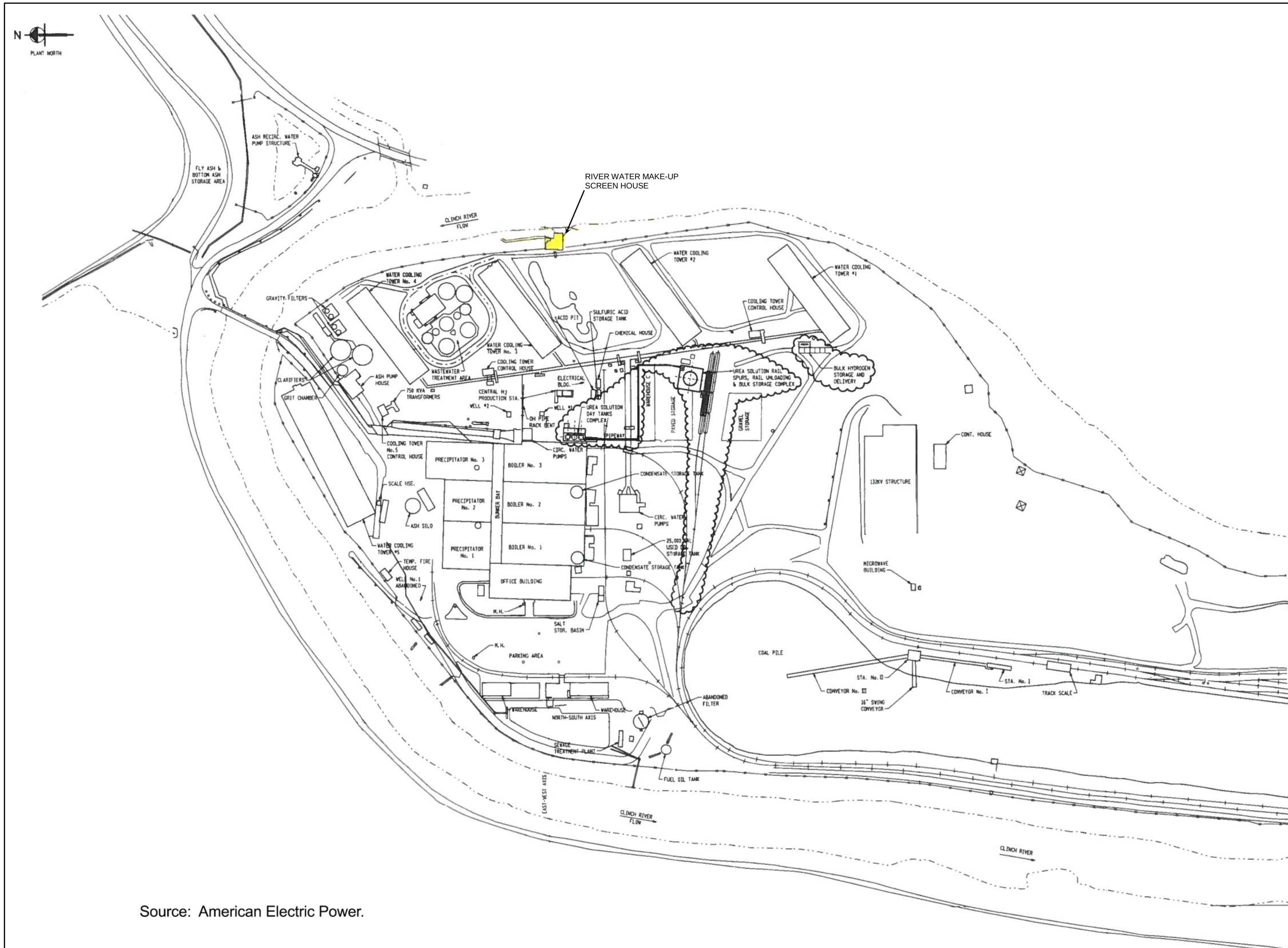
3.1 Description of CWIS Configuration [§122.21(r)(3)(i)]

The Clinch River Plant cooling system is a closed-cycle system; that is, the cooling water is recycled and reused in the steam turbine condensers. The plant currently has two generating units (Units 1 and 2); Unit 3 was permanently retired in May 2015. Approximately 65% of the design intake water is used for cooling. The current design flow for make-up from the Clinch River is 9.36 MGD (6,500 GPM). The Clinch River Plant has a single river CWIS to serve its two generating units, located at River Mile 268.0 (see Figures 2-1 and 3-1).

The intake structure is located approximately flush with the shoreline and oriented perpendicular to the direction of Clinch River flow. One of the three river make-up pumps are required for normal operation with two Units and two pumps held in standby mode. Each river water pump has a rated capacity of 6,500 GPM. The intake structure has two 7 ft-2 in. wide intake openings and contains two conventional traveling water screens (TWS) with each basket frame measuring 6 ft wide by 2 ft high and 3/8-inch square mesh openings (Figure 3-2). It is assumed that the screen mesh dimensions (where water flows through) for each basket are 71 in. wide by 21 in. high (i.e., 10.3 ft^2). U.S. Filter has provided a percent open area (POA) of 67.9 for a screen with 3/8-in. square openings and #14 (0.080 in. diameter) mesh wire. The bottom of the screens are located at elevation 1,484 ft, compared to a low water level of 1,488 ft, and normal pool level of 1,498 ft.

The trash rakes are installed with a water level differential recorder in order to remove trash and debris from the water before it enters the traveling water screens and river water makeup pumps. The motor-operated trash rakes function to remove large debris from the front of the intake structure that is caught on the trash rack bars. The rakes are manually operated. If the water level differential across the trash rake becomes excessive, a signal is sent to the plant’s control room. When the control operator receives this alarm signal, he must have the trash rack cleaned immediately to prevent possible loss of suction to the river makeup pumps. Surface ice buildup is not an issue at the intake; therefore, no treatment and operational measures are necessary.

Water for washing debris from the traveling screens is supplied by two screen wash pumps located in the intake house. Each pump is rated at 850 GPM at 225 ft. Total Dynamic Head (TDH) and is driven by a 75-hp, 1,750-rpm and 550-volt motor. Each pump takes suction via a 6-in line, derived from the south river makeup pump discharge header downstream of the 24-in self-cleaning strainer. The suction lines are equipped with shut-off valves. Each discharge line is equipped with a check valve and two shut-off valves. The rotating screens are each driven by a two-speed (2hp/1hp), 550-volt motor, and can be operated either manually from local switches in the intake house or automatically. Each screen is equipped with a dual-level recorder-controller which starts the screen wash pump motors when a predetermined water level differential exists across the screen.



Source: American Electric Power.

Figure 3-1. Clinch River Plant Plot Plan

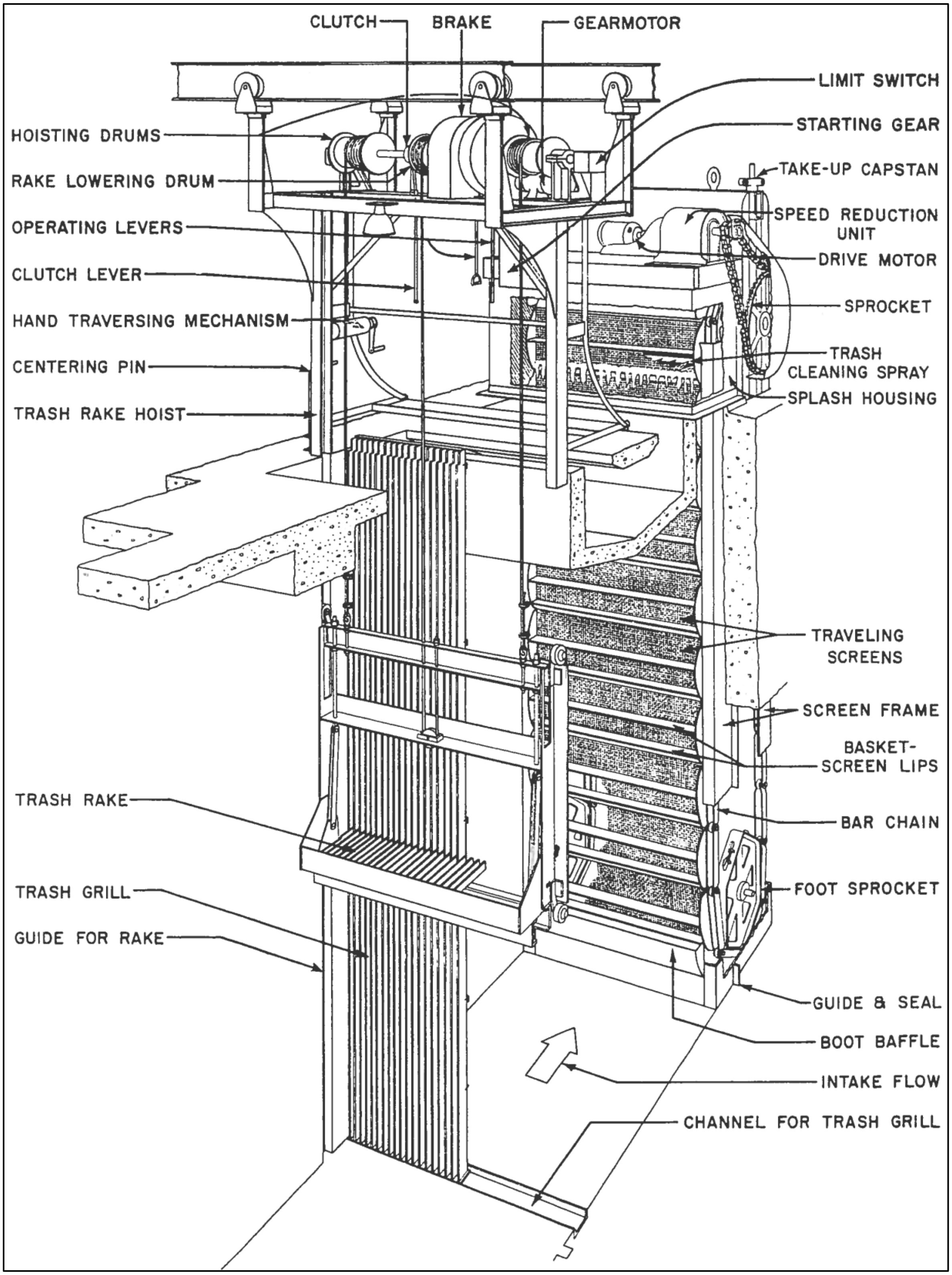


Figure 3-2. Traveling Screen and Trash Rake at Clinch River Plant

The screen-wash system is designed to operate: (1) automatically if the screen water level differential becomes excessive, (2) automatically for sufficient times for the screen to make approximately one revolution in each 24 hours regardless of screen water level differential, and (3) started manually by a push button in the intake house. When the screen wash pump and rotating screen motor control switches are set for automatic operation, the screen wash pump starts and establishes a water pressure. The existence of this pressure in turn starts the rotating screens via a pressure switch. The screen wash system will continue to operate as long as an excessive through-screen water level differential exists. If no screen wash level differential exists, the rotating screens and the screen-wash pump stop running. A running-time meter is provided for each screen wash pump motor. It records the number of hours of operation for each pump.

There are three river water makeup pumps, with each pump rated at 6,500 GPM at 50 ft TDH and driven by a 125 hp, 860 rpm, 550 volt motor. The pumps can be operated either remotely from control switches in the plant's main control room, or locally from switches in the intake house. Normally, two pumps are capable of providing the requirements of all three units, with the third pump in reserve. The three pumps discharge into a 36-inch water main to the plant, which in turn feeds two 24-in pipes.

Each outlet is equipped with a 24-inch motor-operated, self-cleaning strainer which operates automatically to clean itself when a high differential pressure exists across it. This involves 2-5% of the water being discharged backwards through an isolated vertical section of the strainer to wash the debris into a drain box. The backwashing water and refuse are discharged from the bottom of the strainer body to the trash trough. The strainers can also be operated manually. See Figure 3-3 for a schematic of the river makeup water and screen wash pumps.

3.2 Latitude and Longitude of CWIS [§122.21(r)(3)(ii)]

Intake coordinates are:

Latitude: 36° 56’ 0.5” N
Longitude: 82° 11’ 49.0” W

3.3 Description of CWIS Operation [§122.21(r)(3)(iii)]

The Clinch River Plant and its cooling water system are intended for year-round, 24 hours/day operation, with the exception of down time due to outages. Units 1 and 2 can each generate 235 MW. Net capacity factors and annual net generation prior to Unit 3 retirement for years from 2007 to 2013 are shown in Table 3-1.

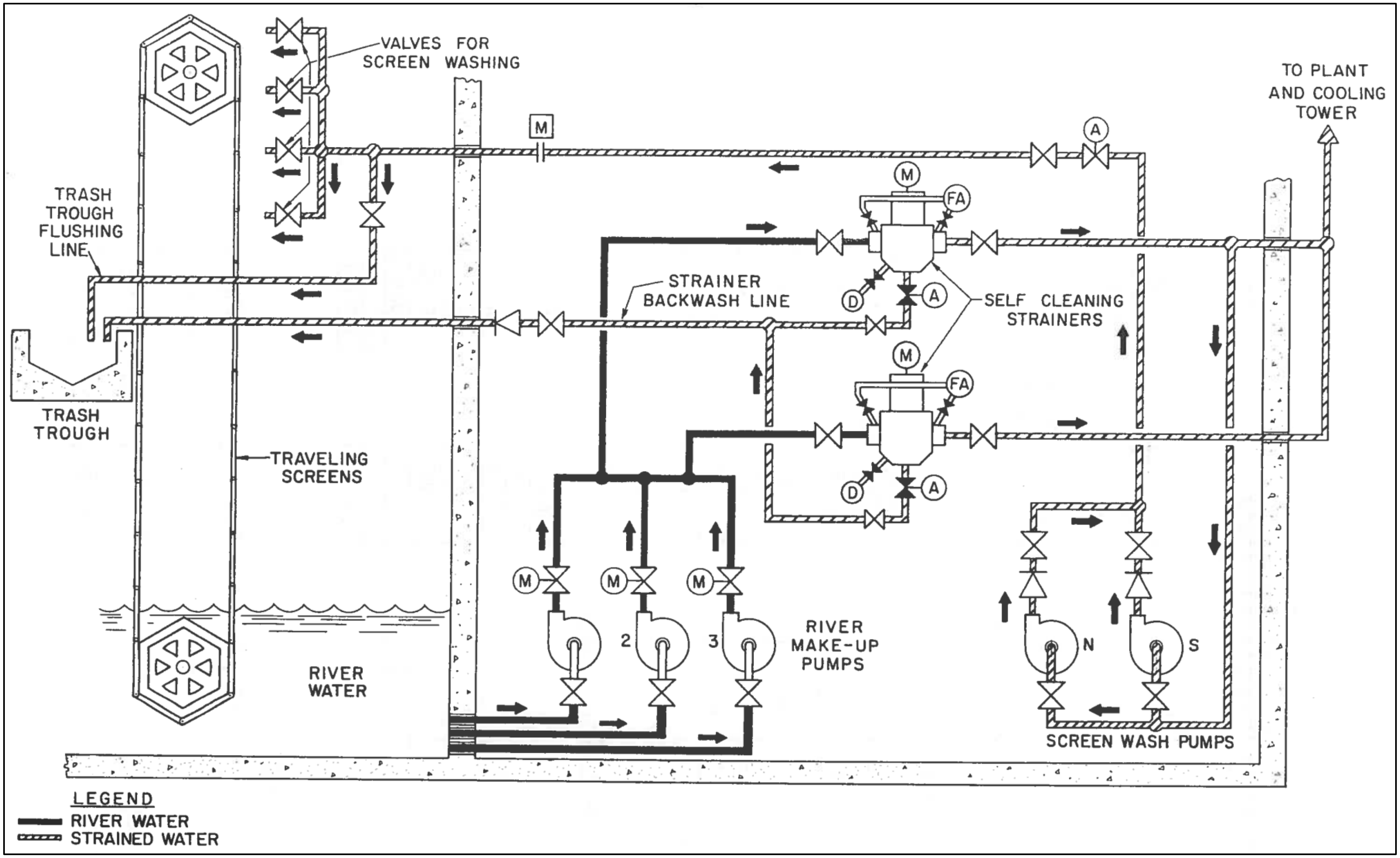


Figure 3-3. Schematic of River Makeup Water and Screen Wash Pumps at Clinch River Plant

Table 3-1. Clinch River Plant Net Capacity Factors (%) and Annual Net Generation (MWh)

Year	Net Capacity Factor (%)			Annual Net Generation (MWh)		
	Unit 1	Unit 2	Unit 3	Unit 1	Unit 2	Unit 3
2013	18.54	12.58	12.51	381,602	258,996	257,475
2012	20.46	11.18	7.37	422,358	230,700	152,036
2011	14.52	24.14	24.50	298,971	496,891	504,316
2010	36.39	24.46	12.06	749,133	503,488	248,302
2009	21.34	11.25	42.02	439,257	231,518	865,034
2008	53.29	59.99	62.62	1,099,996	1,238,405	1,292,524
2007	64.21	63.68	68.87	1,321,779	1,310,952	1,417,742
7-Year Avg	**32.68**	**29.61**	**32.85**	**673,299**	**610,136**	**676,776**

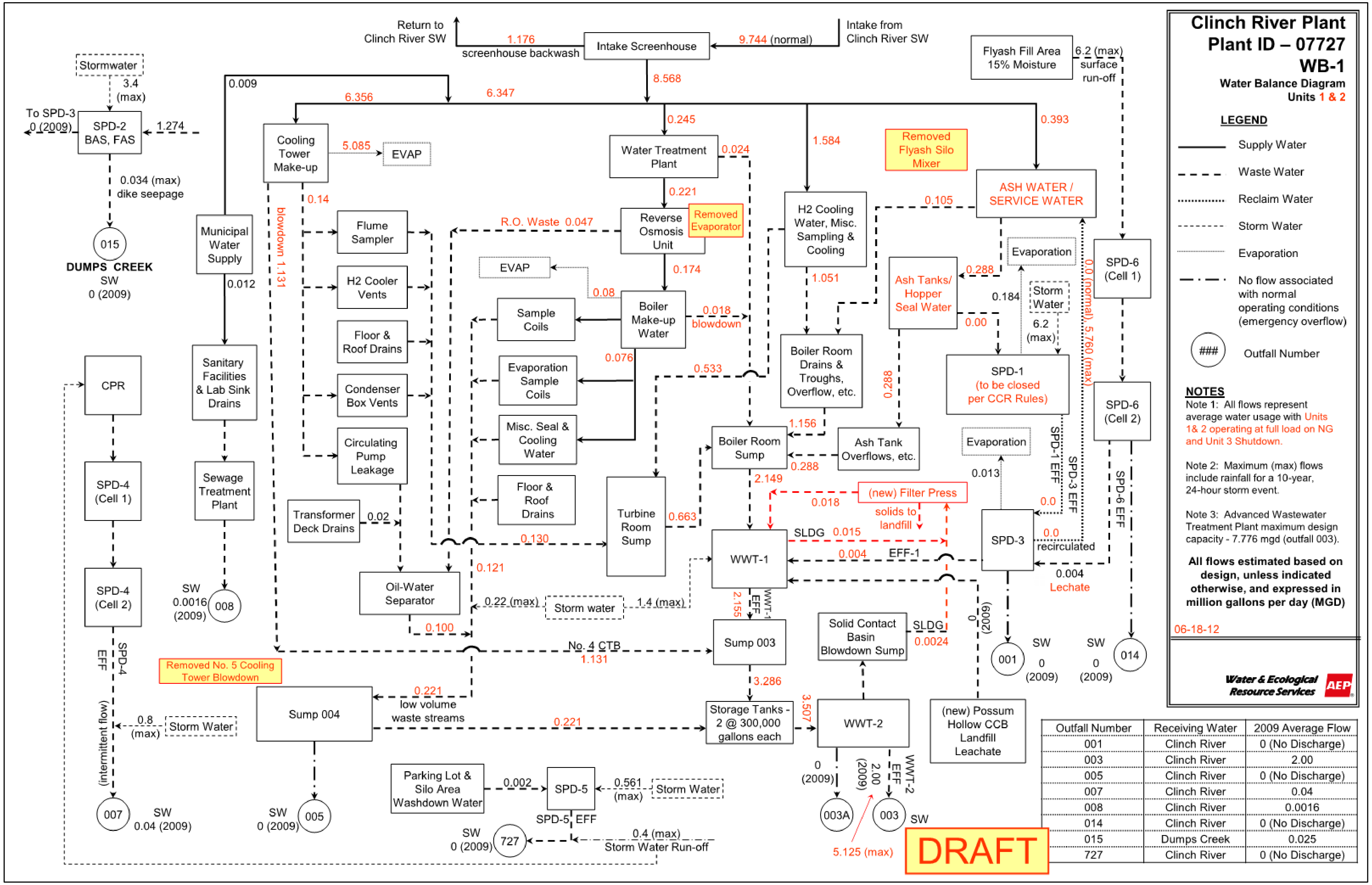
3.4 Description of Intake Flows [§122.21(r)(3)(iv)]

Figures 3-4 presents a water balance diagrams for the current operation (i.e., after the retirement of Unit 3).

3.5 Engineering Drawings of CWIS [§122.21(r)(3)(v)]

Following engineering drawings of river water make-up intake structures are provided in Appendix A:

- Drawing No.13-5024-15: Clinch River Plant Plot Plan
- Drawing No.12-5112-7: Screen House Arrangement, Make Up, Screen Wash and Drainage Piping (Unit 1 and 2)



Outfall Number	Receiving Water	2009 Average Flow
001	Clinch River	0 (No Discharge)
003	Clinch River	2.00
005	Clinch River	0 (No Discharge)
007	Clinch River	0.04
008	Clinch River	0.0016
014	Clinch River	0 (No Discharge)
015	Dumps Creek	0.025
727	Clinch River	0 (No Discharge)

Figure 3-4. DRAFT Water Balance Diagram of Clinch River Plant Post Retirement of Unit 3 in May 2015

4 Source Water Baseline Biological Characterization Data [§122.21(r)(4)]

4.1 List of Unavailable Biological Data [§122.21(r)(4)(i)]

The data needed to prepare all elements of § 122.21(r)(4) were available.

4.2 List of Species and Relative Abundance in the vicinity of CWIS [§122.21(r)(4)(ii)]

There were data collected near the Clinch River Plant by AEP and the VADEQ. The sampling locations are shown in Figure 4-1. The AEP monitoring data were collected from three locations (Stations 4, 7, and 9) on the Clinch River near Clinch River Plant on the following dates:

- 19-20 July 1982;
- 19-20 July 1983;
- 28-29 August 1984;
- 30 July 1986;
- 22-23 July 1987;
- 12-13 July 1988;
- 24-25 July 1990; and
- 26-27 August 1991

Sampling was performed by AEP biologists. Sample Station 4 was located 2.5 river miles downstream of Cleveland, VA and 1.4 river miles upstream of the Clinch River Plant water intake (CRM 268.0) at CRM 269.4. Sample Station 7 was located downstream of Clinch River Plant wastewater discharges at CRM 267.2. Station 9 was located immediately downstream of the bridge at Carterton, VA, on Rt. 665 and approximately 3.3 miles downstream of Clinch River Plant at CRM 264.1 (AEP 1982-1991). Although the AEP data are about 20 years old, the species collected and community dominants are very similar to the more recent VDEQ data; for this reason the AEP data provide valuable supplemental information.

Data were collected by VADEQ on October 21 and 28, 2010. Sampling was conducted by state biologists at two locations: Sample ID 6BCLN250.67 record (28) was collected ~17 miles downstream of the Clinch River (Latitude: 36.89092; Longitude: -82.32846) and sample ID 6BCLN273.19 record (41) was collected ~5.5 miles upstream of the Clinch River Plant (Latitude: 36.95336; Longitude: -82.13814) (deq.virginia.gov).

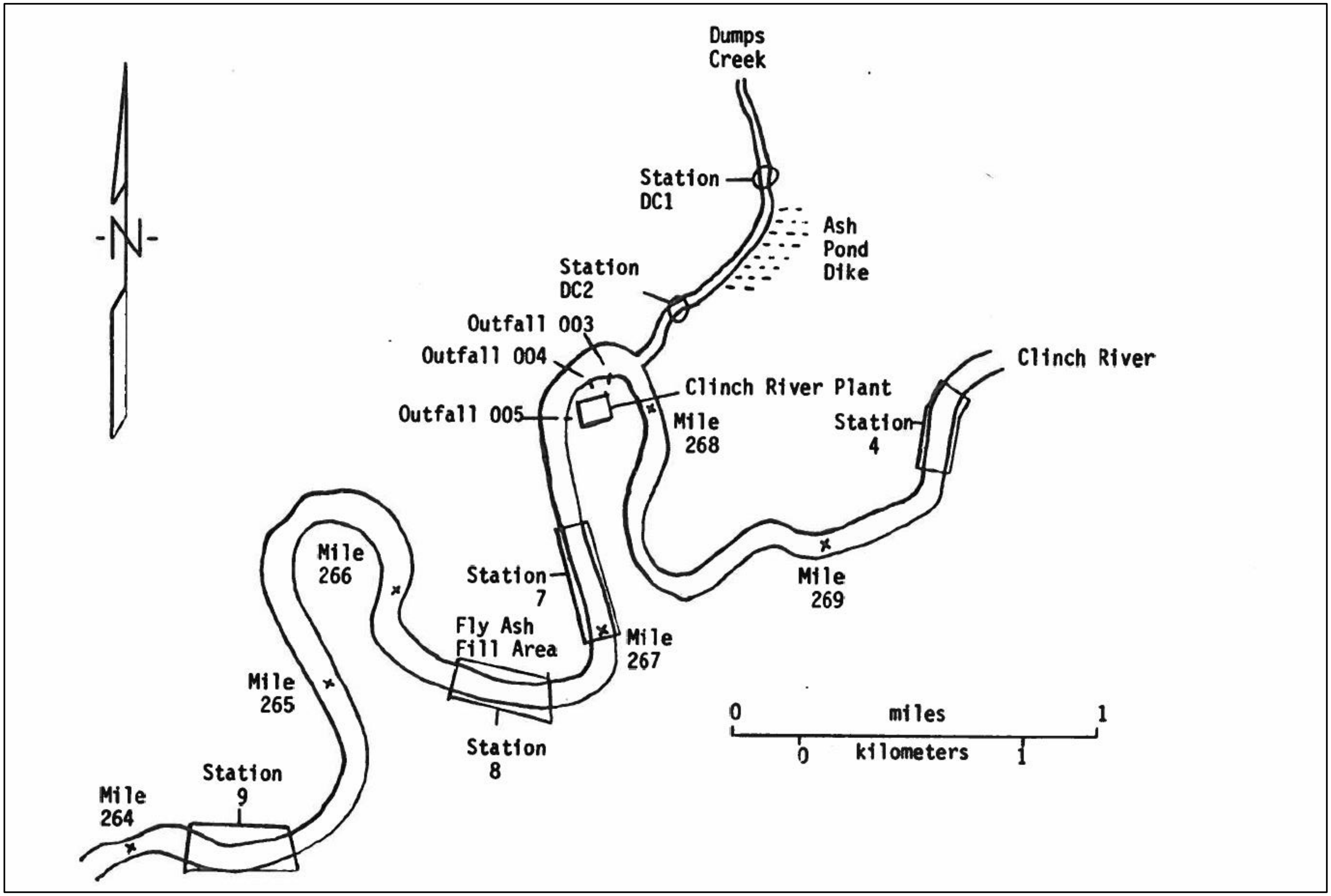


Figure 4-1. Biological Sampling Stations in the Clinch River near Clinch River Plant

AEP fish sampling was conducted in areas of the river channel containing both pool and riffle habitats and blocked off using 0.25-in mesh block nets. The length of enclosed areas was approximately 200 ft (range 170-210 ft). Channel width varied from 75-120 ft. Fish were sampled using a pulse DC electroshocker (300 v; 5-7 A) mounted on a 5-ft square raft. Using a three-man crew (2 netters, 1 operator), depletion sampling was performed by collecting all stunned fishes in three consecutive runs within the blocked-off area. Most fishes were then field identified and returned live to the river. Voucher specimens and specimens of uncertain identification were preserved in 10% formalin and returned to the laboratory (AEP 1982-1991).

VADEQ data were collected from an electrofishing boat. All habitat types present within the 2,000 foot survey areas were represented in the samples, both sites were fished for 7,500 seconds. Field teams consisted of a three-man crew (2 netters, 1 operator), all stunned fishes were collected (deq.virginia.gov). AEP's July and August samples would fall under summer catch data, while the VADEQ October samples are considered fall catch data. One would expect higher YOY counts during AEPs summer samples and less YOY during VADEQ fall samples; both of which are reflected in the data set (see Table 4-1).

Fish collected by electrofishing near Clinch River Plant by AEP from 1982 to 1991 and their relative abundance along with data collected by the state of Virginia Department of Environmental Quality (VADEQ) during sampling performed on October 21 and 28, 2010 are presented in Table 4-1.

Table 4-1. Relative Abundance of Fish in the Vicinity of the Clinch River Plant

Family Name	Species (Common Name)	VADEQ Survey 2010	AEP Surveys 1982-1991
Petromyzontidae	Ohio Lamprey	1.17%	0.11%
	Mountain Brook Lamprey	0.29%	0.00%
Lepistosteidae	Longnose Gar	0.10%	0.15%
Clupeidae	Gizzard Shad	0.10%	2.98%
Cyprinidae	Central Stoneroller	8.38%	16.07%
	Whitetail Shiner	1.56%	0.88%
	Spotfin Shiner	1.17%	2.69%
	Speckled Chub	0.00%	0.08%
	Streamline Chub	4.78%	1.35%
	Bigeye Chub	3.02%	2.46%
	Blotched Chub	0.00%	8.05%
	YOY Chubs (unidentified)	0.00%	0.20%
	Striped Shiner	1.36%	1.42%
	Warpaint Shiner	0.10%	0.60%
	River Chub	3.61%	1.08%
	Popeye Shiner	0.00%	0.95%

Family Name	Species (Common Name)	VADEQ Survey 2010	AEP Surveys 1982-1991
	Tennessee Shiner	11.99%	9.29%
	Highland Shiner	2.53%	0.00%
	Silver Shiner	3.02%	0.84%
	Sawfin Shiner	1.56%	0.70%
	Rosyface Shiner	0.00%	0.70%
	Telescope Shiner	1.07%	0.41%
	Mimic Shiner	3.41%	0.74%
	Steelcolor Shiner	0.00%	0.20%
	YOY Shiners (unidentified)	0.00%	10.21%
	Stargazing Minnow	0.00%	2.57%
	Bluntnose Minnow	1.36%	1.50%
	Creek Chub	0.00%	0.27%
	Rosyside Dace	0.00%	0.03%
	Western Blacknose Dace	0.39%	0.00%
Catastomidae	White Sucker	0.00%	0.03%
	Northern Hogsucker	4.09%	6.20%
	Smallmouth Redhorse**	1.46%	0.00%
	Silver Redhorse	0.00%	0.01%
	River Redhorse	0.00%	0.38%
	Shorthead Redhorse**	0.00%	1.77%
	Black Redhorse	4.68%	0.54%
	Golden Redhorse	0.97%	3.40%
	YOY Redhorse (unidentified)	0.00%	0.20%
Ictaluridae	Yellow Bullhead	0.10%	0.08%
	Channel Catfish	0.00%	0.04%
	Mountain Madtom	1.66%	0.01%
	Flathead Catfish	0.19%	0.03%
Cottidae	Clinch Sculpin	0.19%	0.00%
Centrarchidae	Rock Bass	3.61%	2.88%
	Redbreast Sunfish	0.97%	0.64%
	Bluegill	0.10%	0.79%
	Longear Sunfish	0.88%	2.68%
	Longear x Green Sunfish Hybrid	0.00%	0.01%
	Smallmouth Bass	1.46%	1.77%

Family Name	Species (Common Name)	VADEQ Survey 2010	AEP Surveys 1982-1991
	Spotted Bass	0.00%	0.24%
	Largemouth Bass	0.39%	0.16%
Percidae	Greenside Darter	6.53%	5.71%
	Bluebreast Darter	1.07%	0.16%
	Fantail Darter	0.00%	0.08%
	Ashy Darter	0.10%	0.00%
	Redline Darter	10.82%	2.52%
	Snubnose Darter	1.07%	0.01%
	Speckled Darter	2.05%	0.24%
	Tippecanoe Darter*	0.00%	0.05%
	Wounded Darter	0.10%	0.18%
	Banded Darter	2.44%	0.84%
	Tangerine Darter	1.27%	0.08%
	YOY Darters (unidentified)	0.00%	0.32%
	Blotchside Logperch	0.29%	0.00%
	Logperch	0.10%	0.46%
	Gilt Darter	2.24%	0.74%
	Dusky Darter	0.00%	0.15%
	Sauger	0.00%	0.01%
	Walleye	0.19%	0.00%

Data Source: deq.virginia.gov; AEP 1982-1991

Note: *Tippecanoe Darter (Ohio and Cumberland drainages) is also known as the Golden Darter in the Upper Tennessee River Drainage

** The Shorthead and Smallmouth Redhorse have been separated by drainages.

Table 4-2 below summarizes relative abundance by family of fish near the Clinch River Plant from VADEQ 2010 and AEP 1982-1991 Surveys.

Table 4-2. Relative Abundance by Family of Fish Near the Clinch River Plant

Family Name	VADEQ Survey 2010	AEP Surveys 1982-1991
Petromyzontidae	1.46%	0.11%
Lepistosteidae	0.10%	0.15%
Clupeidae	0.10%	2.98%
Cyprinidae	49.32%	63.31%
Catastomidae	11.21%	12.54%
Ictaluridae	1.95%	0.16%
Cottidae	0.19%	0.00%
Centrarchidae	7.41%	9.18%
Percidae	28.27%	11.57%

The ten most abundant fish species found within the Clinch River by each sampling study (the 2010 VADEQ and 1982-1991 AEP) are listed below in Table 4-3.

Table 4-3. Ten Most Abundant Fishes Collected during VADEQ 2010 & AEP 1982-1991 Electrofishing Surveys on the Clinch River

Rank	VADEQ 2010		AEP 1982-1991	
	Common Name	% Composition	Common Name	% Composition
1	Tennessee Shiner	11.99%	Central Stoneroller	16.07%
2	Redline Darter	10.82%	YOY Shiners (unidentified)	10.21%
3	Central Stoneroller	8.38%	Tennessee Shiner	9.29%
4	Greenside Darter	6.53%	Blotched Chub	8.05%
5	Streamline Chub	4.78%	Northern Hogsucker	6.20%
6	Black Redhorse	4.68%	Greenside Darter	5.71%
7	Northern Hogsucker	4.09%	Golden Redhorse	3.40%
8	River Chub	3.61%	Gizzard Shad	2.98%
9	Rock Bass	3.61%	Rock Bass	2.88%
10	Mimic Shiner	3.41%	Spotfin Shiner	2.69%
	Total	**61.89%**	**Total**	**67.48%**

These ten fish species accounted for 61.9% of the 2010 VADEQ sampling and 67.48% of the 1982-1991 AEP sampling. While there are differences in the dominate species over these two data sets, five of the most abundant species were observed within both sampling efforts. Of these species, the Tennessee shiner was the most abundant in VADEQ 2010, while the central stoneroller was the most abundant in the AEP 1982-1991 sampling efforts. In total 47 species were observed in the VADEQ 2010 sampling, while 62 species were observed in the AEP 1982-1991 sampling efforts. Because the AEP sampling was conducted over a 9-year period, it is not surprising that a greater number of species were observed in the samples.

4.3 Identification of Species and Life Stages Susceptible to I & E [§ 122.21(r)(4)(iii)]

The use of water from rivers for cooling power stations potentially impacts fishes in many ways, most directly through impingement and entrainment. In order to provide perspective on species likely to be susceptible to impingement and entrainment, monitoring data from AEP biologists along with VADEQ stream bioassessment data were reviewed. For reference, a two year sampling program was undertaken on the Ohio River (King et al. 2011). The 2005 and 2006 impingement abundance monitoring and standardized fish sampling studies near 15 Ohio River power plants were conducted as part of the Ohio River Ecological Research Program (ORERP) (King, et al., 2011). This study suggested impingement of fishes at intake structures was selective and did not represent the full species assemblages in the source waterbody. In particular, impingement data were compared to seasonal electrofishing and seining data to determine species composition and relative abundance. King et al. (2011) evaluated potential explanations for the presence, absence, or disproportionate occurrence of fishes between the two data sets. The impingement study demonstrated parallels in species composition among power plants over nearly 870 river miles of the Ohio River. The river surveys indicated that the abundance of some species varied significantly over the length of the river. However, Clupeids dominated the impingement collections at much higher levels than suggested by the populations encountered during the river surveys. Other forage species, especially Emerald Shiner and Channel Shiner, were under represented in the impingement collections.

While the Ohio River is a much larger river system than the Clinch River, the following study demonstrates how impingement and entrainment potentially affect various fish species and families at similar power plants. Several of the species and families mentioned are represented in both river systems and species behavior and habitat needs are alike in each river. It should be noted that while the overall conclusions about species composition subject to impingement are useful, much of the King, et al., 2011 data collected at cooling water intakes that use larger proportions of river flow and have substantially higher through-screen velocities than those present at the Clinch River Plant. For these reasons, the rates of impingement at the power plants on the Ohio River are likely to be higher than at the Clinch River Plant (see Appendix B for engineering calculations of through-screen velocities).

During the two-year river study on the Ohio River, 32 species collected were not impinged (King et al. 2011). On the other hand, 13 species were impinged that were not collected during the river surveys. The impingement study indicated that many species in the Ohio River are not particularly susceptible to impingement due to behavior, habitat preferences, or low population levels. This was evident for Carps and Minnows (Family Cyprinidae), Darters (Family Percidae), and Redhorse (*Moxostoma* spp.). The opposite was true for abundant, pelagic schooling Clupeids that were occasionally impinged at very high rates. Often higher Clupeid impingement rates were observed during periods of declining water temperatures. Channel Catfish (*Ictalurus* *punctatus*) were also impinged at much higher rates than would be predicted based on their abundance in the river collections (King et al. 2011*).* Similar species-specific differences between source water relative abundance and relative rates of impingement are expected to take place on other rivers with like species such as the Clinch River.

All species present within the Clinch River have the potential to be affected by impingement and entrainment, however the vast majority of fishes are unlikely to be affected based on multiple factors (see Table 4-4).

Based on life history, feeding and spawning habits, species abundance, and on previously collected fisheries data, no species are expected to be susceptible to impingement and four have the potential to be vulnerable to entrainment at the Clinch River Plant (see Table 4-5).

The primary factors behind the selection of these species are their known tendencies to gather in large schools and the fact that they are predominately pelagic spawners with either demersal adhesive or semi-buoyant demersal eggs. The broadcast spawners in this group exert no parental investment, increasing the likelihood of entrainment during early life stages.

Table 4-4. Impingement and Entrainment Potential

Common Name	Scientific Name	Potential to Occur Near the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles**
LAMPREY				
Ohio Lamprey	*Ichthyomyzon bdellium*	Early life stages – Unlikely, spawn in riffles. Adults and Juveniles – Unlikely young burrow into sediment. Adults – low density, parasitic.	Unlikely	Unlikely
Mountain Brook Lamprey	*Ichthyomyzon greeleyi*	Early life stages - Unlikely, spawn in riffles. Adults and Juveniles - Unlikely young burrow into sediment. Adults – remain in smaller streams	Unlikely	Unlikely
GAR				
Longnose Gar	*Lepisosteus osseus*	Early life stages – Unlikely, newly hatched young adhere to submerged substrate. Adults and Juveniles – Unlikely due to feeding habits	Unlikely	Unlikely
SHAD				
Gizzard Shad	*Dorosoma cepedianum*	Early life stages– Likely, broadcast spawners Adults and Juveniles - Likely, congregate near outfall not far from intake, attracted to current	Yes	Unlikely
SALMON/TROUT				
Rainbow Trout	*Oncorhynchus mykiss*	Early life stages – Unlikely, no natural reproduction in the Clinch River - stocked Adults and Juveniles – Unlikely, prefer cooler waters - primarily found near tributaries	Unlikely	Unlikely
PIKE				
Muskellunge	Esox Masquinongy	Early life stages - Unlikely, shallow spawners Adults and Juveniles - Unlikely due to feeding habits	Unlikely	Unlikely

Common Name	Scientific Name	Potential to Occur Near the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles**
CARP / MINNOW				
*Unlikely based on previous data, spawning, and feeding habits				
Common Carp	*Cyprinus carpio*	Early life stages – Possible, broadcast spawners Adults and Juveniles – Unlikely, avoid current	Unlikely	Unlikely
Spotfin Shiner	*Cyprinella spiloptera*	Adults and Juveniles – known to school near currents, high density sp.	Potentially	Unlikely
Striped Shiner	*Luxilus chrysocephalus*	Adults and Juveniles – School near currents	Unlikely	Unlikely
Rosyside Dace	*Clinostomus funduloides*	Early life stages – Unlikely, spawn in riffles. Adults and Juveniles – Unlikely, attracted to deep pools and woody debris.	Unlikely	Unlikely
Speckled Chub	*Macrhybopsis aestivalis*	Adults and Juveniles – Prefers large flowing river channels with gravel and sand.	Unlikely	Unlikely
Bigeye Chub	*Hybopsis amblops*	*	Unlikely	Unlikely
Streamline Chub	*Erimystac dissimilis*	Adults and Juveniles – Often found in smaller streams - Prefer swift currents in 1~4 ft of water.	Unlikely	Unlikely
Highland Shiner	*Notropis micropteryx*	Early life stages – eggs sink and stick to substrate. Adults and Juveniles – found in swift currents over gravel.	Unlikely	Unlikely
Western Blacknose Dace	*Rhinichthys obtusus*	Adults and Juveniles – Often found in smaller high gradient streams. Prefer riffles	Unlikely	Unlikely
Blotched Chub	*Erimystax insignis*	(*) Adults and Juveniles – Often found in smaller high gradient streams - Prefer riffles.	Unlikely	Unlikely
River Chub	*Nocomis micropogon*	Early life stages – Unlikely, males defend nest. Adults and Juveniles – Typically found in larger streams & medium size rivers, found in deep pools and swift currents.	Unlikely	Unlikely

Common Name	Scientific Name	Potential to Occur Near the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles**
Popeye Shiner	*Notropis ariommus*	(*) Adults and Juveniles – sp. is seldom very common, highly localized	Unlikely	Unlikely
Silver Shiner	*Notropis photogenis*	Adults and Juveniles – School near currents	Unlikely	Unlikely
Rosyface Shiner	*Notropis rubellus*	Early life stages – eggs sink and stick to substrate. Adults and Juveniles – found in swift currents over gravel.	Unlikely	Unlikely
Warpaint Shiner	*Luxilus coccogenis*	Adults inhabit gravel riffles adjacent to pools in clear waters. Nest spawners	Unlikely	Unlikely
Whitetail Shiner	*Cyprinella galactura*	Adults and Juveniles – Inhabit rocky runs more often than pool and riffles.	Unlikely	Unlikely
Telescope Shiner	*Notropis telescopus*	Adults and Juveniles – Inhabit rocky runs and flowing pools, often near riffles.	Unlikely	Unlikely
Mimic Shiner	*Notropis volucellus*	Early life stages – Potentially, broadcast spawn. Typically found in larger to moderate size streams and rivers, high density sp.	Potentially	Unlikely
Steelcolor Shiner	*Cyprinella wipplei*	Early life stages– eggs sink and stick to substrate. Adults and Juveniles – found in swift currents over gravel. Often school near the top and middle of the water column.	Unlikely	Unlikely
Sawfin Shiner	*Notropis sp.*	Adults and Juveniles – Sometimes forms moderate-sized schools. Low density sp.	Unlikely	Unlikely
Stargazing Minnow	*Phenacobius uranops*	Young are often found near beds of water willow and margins of flowing pools. Adults typically found over very slightly silted gravel and small to medium rubbles.	Unlikely	Unlikely
Tennessee Shiner	*Notropis leuciodus*	Prefers pool and runs, usually clear rivers and streams with gravel substrates. Relatively large populations in areas.	Potentially	Unlikely

Common Name	Scientific Name	Potential to Occur Near the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles**
Creek Chub	*Semotilus atromaculatus*	*	Unlikely	Unlikely
Central Stoneroller	*Campostoma anomalum*	*	Unlikely	Unlikely
Bluntnose Minnow	*Pimephales notatus*	*	Unlikely	Unlikely
SUCKER				
* These species have the potential to occur near the intake during larval and early life stages				
Shorthead Redhorse	*Moxostoma macrolepidotum*	*	Unlikely	Unlikely
Northern Hog Sucker	*Hypentelium nigricans*	*	Unlikely	Unlikely
Silver Redhorse	*Moxostoma anisurum*	*	Unlikely	Unlikely
River Redhorse	*Moxostoma carinatum*	*	Unlikely	Unlikely
Smallmouth Redhorse	*Moxostoma breviceps*	*	Unlikely	Unlikely
Black Redhorse	*Moxostoma duquesnei*	*	Unlikely	Unlikely
Golden Redhorse	*Moxostoma erythrurum*	*	Unlikely	Unlikely
White Sucker	*Catastomus commersonii*	*	Unlikely	Unlikely

Common Name	Scientific Name	Potential to Occur Near the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles**
CATFISH				
Channel Catfish	*Ictalurus punctatus*	Early life stages – Unlikely, cavity nesters Adults – No Juveniles – Potentially for feeding/ past surveys have yielded some impacts.	Unlikely	Unlikely
Flathead Catfish	*Pylodictis olivaris*	Early life stages – Unlikely, cavity nesters Adults – No Juveniles – Potentially for feeding	Unlikely	Unlikely
Yellow Bullhead	*Ameiurus natalis*	Early life stages – Unlikely, cavity nesters Adults – No Juveniles – Potentially for feeding	Unlikely	Unlikely
Mountain Madtom	*Noturus eleutherus*	Early life stages – Unlikely, spawn in riffles Adults – Potentially, prefer deep/ swift riffles Juveniles –unlikely, feed in riffles.	Unlikely	Unlikely
SCULPIN				
Clinch Sculpin	*Cottus sp.*	Early life stages – Unlikely, cavity nesters Adults - Potentially	Unlikely	Unlikely
SUNFISH				
* Unlikely based on benthic nesting and feeding habits				
Rock Bass	*Ambloplites rupestris*	*	Unlikely	Unlikely
Bluegill	*Lepomis macrochirus*	*	Unlikely	Unlikely
Green Sunfish	*Lepomis cyanellus*	*	Unlikely	Unlikely
Longear Sunfish	*Lepomis megalotis*	*	Unlikely	Unlikely
Lepomis Hybrid	–	*	Unlikely	Unlikely

Common Name	Scientific Name	Potential to Occur Near the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles**
Redbreast Sunfish	Lepomis auritus	*	Unlikely	Unlikely
BLACK BASS				
* Unlikely based on benthic nesting and feeding habits				
Smallmouth Bass	*Micropterus dolomieu*	*	Unlikely	Unlikely
Largemouth Bass	*Micropterus salmoides*	*	Unlikely	Unlikely
Spotted Bass	*Micropterus punctulatus*	*	Unlikely	Unlikely
DARTER				
*Unlikely based on previous data, spawning, and feeding habits				
Greenside Darter	*Etheostoma blennioides*	*	Unlikely	Unlikely
Ashy Darter	*Etheostoma cinereum*	*	Unlikely	Unlikely
Speckled Darter	*Etheostoma stigmaeum*	*	Unlikely	Unlikely
Redline Darter	*Etheostoma rufilineatum*	*	Unlikely	Unlikely
Snubnose Darter	*Etheostoma simo*	*	Unlikely	Unlikely
Bluebreast Darter	*Etheostoma camurum*	*	Unlikely	Unlikely
Fantail Darter	*Etheostoma flabellare*	*	Unlikely	Unlikely
Blotchside Logperch	*Percina burtoni*	*; low density sp.	Unlikely	Unlikely

Common Name	Scientific Name	Potential to Occur Near the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles**
Johnny Darter	*Etheostoma nigrum*	*	Unlikely	Unlikely
Tippecanoe Darter	*Etheostoma tippicanoe*	*	Unlikely	Unlikely
Wounded Darter	*Etheostoma vulneratum*	*	Unlikely	Unlikely
Banded Darter	*Etheostoma zonale*	*	Unlikely	Unlikely
Tangerine Darter	*Percina aurantiaca*	*	Unlikely	Unlikely
Gilt Darter	*Percina evides*	*	Unlikely	Unlikely
Dusky Darter	*Percina sciera*	*	Unlikely	Unlikely
Logperch	*Percina caprodes*	Adults and Juveniles – Potentially attracted to current. Typically higher populations than Blotchside when found in same habitat.	Unlikely	Unlikely
PERCH				
Walleye	*Sanders vitreus*	Early life stages – Deposit eggs over gravel or boulder-sized rocks in riffle areas Adults and Juveniles – Attracted warm water discharge during colder temperatures	Unlikely	Unlikely
Sauger	*Sander canadensis*	Adults and Juveniles – Attracted warm water discharge during colder temperatures	Unlikely	Unlikely

Note: **Potential for Impingement of Juveniles and Adults assumed to be unlikely for all species due to small AOI and through-screen velocities that are 0.5 fps or less.

Table 4-5. Fish Species Expected to be Most Vulnerable to Entrainment at the Clinch River Plant

Common Name	Scientific Name
Gizzard Shad	*Dorosoma cepedianum*
Mimic Shiner	*Notropis volucellus*
Spotfin Shiner	*Cyprinella spiloptera*
Tennessee Shiner	*Notropis leuciodus*

Note: In the final Rule, EPA has made the argument that impingement is virtually eliminated when through screen velocities are at or below 0.5 ft/s (as will be the case at Clinch River when unit 3 is retired).

4.4 Identification and Evaluation of Primary Growth Period [§ 122.21(r)(4)(iv)]

The primary growth period for the majority of fishes directly follows the spring hatch. Growth rates are highest early and tend to decline throughout the summer along with total fish abundance. Fish are cold blooded, thus primary growth occurs when water temperatures are 50-degrees or above. The generally held view on seasonal variation in fish growth in North America is that growth is fastest in the spring and early summer, slows in the late summer and fall, and virtually stops in the winter (Gebhart et al. 1978). The majority of fishes will have their highest densities shortly after the hatch occurs when larvae are concentrated. Feeding competition is especially important during late spring through early summer when the bulk of fish are in their early life stages. During this time, they are more susceptible to starvation (May 1974). This is a critical stage in development, where larval fish have a short time period to initiate feeding before reaching a point of no return and, ultimately, starving (Ehrlich 1974; Miller et al. 1988).

4.4.1 Reproduction

Clinch River fishes almost always have external fertilization, which is principally controlled by water temperatures. Fish reproduction has the potential to produce high yields; however, mortality rates are also high. Additionally, most fish spawn only once a year regardless of prior success. Fecundity refers to the number of eggs a female produces and can vary widely depending on the risk level associated with various types of spawning methods and the amount of parental investment.

Reproduction activities for the four species with the highest risk of entrainment (Table 4-5) are as follows: Gizzard Shad *(Dorosoma cepedianum)* a member of the *Clupeidae* family reproduces from mid-March to later August, with the bulk of the population spawning in May and June when temperatures range from 15.6-22.8°C (Wallus et al. 1990). Gizzard Shad are extremely prolific spawners and therefore have very high larval densities (Storck et al. 1978). The remaining three species are all members of the *Cyprinidae* family. Spotfin Shiner

(*Cyprinella spiloptera)* spawning occurs from mid-June to mid-August and mostly occurs in the morning (Jenkins and Burkhead 1993). Eggs are typically deposited in crevices formed by loose bark on submerged trees and stumps (Trautman 1981). Both male and female Mimic Shiners (*Notropis volucellus)* mature at 1 year of age. In Virginia, breeding occurs between May and early August and takes place over sand or gravel substrates in shallows and riffles (Jenkins and Burkhead 1993). Little is known about the life history of the Tennessee Shiner (*Notropis leuciodus).* Some fish don't mature until 2 years of age. Reproduction activities are known to occur during spring and early summer when temperatures are 17-25.6°C (Outten 1962). Spawning typically occurs over chub nests where 20-50 males gather in a school. However, spawning has also been known to occur over shallow gravel runs without nests (Jenkins and Burkhead 1993).

4.4.2 Larval Recruitment

Peak larval recruitment for most Clinch River fishes generally occurs between April and July. As a result, peak larval fish entrainment would be expected to be more prevalent during the same period. Young of year (YOY) for the majority of fishes are most abundant shortly after the spring and summer spawning period. It is unlikely that large numbers of eggs and larvae would become entrained at the Clinch River Plant given the predominately required spawning habitat (riffle / shallow water habitats) of the adults.

4.4.3 Period of Peak Abundance

Fish spawning is a direct function of water temperature, constraining most activity to the spring and early summer months with limited species spawning in the fall. This results in huge influxes of larval and juvenile fishes into the Clinch River system drainage each year when water temperatures begin to rise. Peak abundance for most juvenile fishes occurs between May and August depending on each species' unique spawning habits. Activities for the four species with the highest risk of entrainment are as follows.

Gizzard Shad of the Age-0 class are most abundant during late spring through early fall and dominate the diets of predators during this early life stage (Michaletz 1998). Gizzard Shad growth rates tend to be highest early after hatch, and decline throughout the summer (Welker 1994). Studies have shown that peak shad populations occurred between May 11 and June 22. The timing of peak density differs from year to year for every population and is likely correlated to variances in water temperature, with the highest densities corresponding to 17-22°C waters that had been stable or rising (Zweifel et al. 2009).

Mimic Shiner (*Notropis volucellus)* both male and females mature sexually at 1 year of age; 2 year old fish occur in relatively low numbers with 3 year old fish being extremely rare (Becker 1983). In-depth knowledge regarding the Mimic Shiner's life history is lacking. Peak density is directly correlated to the spawning time which is a function of temperature. Mimic Shiners are thought to spawn in early summer (Stauffer et al., 1995). Therefore, peak abundance is likely to occur between late-June and September.

Spotfin Shiner (*Cyprinella spiloptera)* are fractional spawners, a strategy that greatly increases reproductive potential. Breeding pairs have been known to spawn up to 12 times during a 1 to 7 day period from June 16 to August 10 in shallow pools. 169-945 eggs were observed to be released per spawning episode, totaling 7,474 eggs (Stone 1940, Gale and Gale 1977). Mature fish are 1-2 years of age with some being noted as living to the age of 5 (Jenkins and Burkhead 1993). They often become very abundant in areas with poor habitat for other species. Peak abundance is likely to occur in mid-to-late summer once eggs have hatched and YOY are plentiful with the optimum temperature range for maximum survival at 20.1 - 29.9°C (Kellogg and Gift 1983).

The life history of the Tennessee Shiner (*Notropis leuciodus)* is poorly understood and little is known about larval recruitment. In Virginia, this species is only found in the southwest corner of the state and often schools with other shiners such as the Rosyface and Telescope Shiners (Jenkins and Burkhead 1993). Reproduction activities are known to occur during spring and early summer; peak YOY numbers will likely occur during late summer into early fall.

4.5 Data Representative of Seasonal and Daily Activities of Organisms in the Vicinity of CWIS [§ 122.21(r)(4)(v)]

This information is summarized in Table 4-6 for the dominant species observed in the Clinch River in the vicinity of the Clinch River Plant.

Table 4-6. Seasonal and Daily Activities

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
LAMPREY			
Ohio Lamprey	*Ichthyomyzon bdellium*	Ohio lampreys spawn in late May or early June in shallow pits typically near the upper end of gravel riffles.	After hatching, the larval stage lampreys burrow into sediment where they feed on organic matter for several years. They then transform into parasitic adults in the spring. The following spring adults then typically migrate into smaller rivers where they spawn and then die shortly afterward.
Mountain Brook Lamprey	*Ichthyomyzon greeleyi*	Spawn in March and April in shallow pits typically near the upper end of gravel riffles. Typically move from larger river systems to smaller rivers and streams for spawning.	After hatching, the larval stage lampreys burrow into sediment where they feed on organic matter for three years. They then transform into non-parasitic adults in late summer or fall. Adults typically stay in smaller rivers and streams and do not feed. The following spring adults spawn and then die shortly afterward.
GAR			
Longnose Gar	*Lepisosteus osseus*	Spawning takes place in the late May or early June often in shallow riffles. The longnose gar migrates into smaller streams to spawn.	Although post larval longnose gar feed throughout the day, peak feeding activity was observed between 2:00 and 6:00 pm. Both adult and young of year longnose gar feed more actively at night than during the day.
SHAD			
Gizzard Shad	*Dorosoma cepedianum*	Seasonally variable diet dominated by zooplankton and organic detritus in early summer and consisting more exclusively of detritus throughout the rest of the growing season.	Inhabits slow moving or standing waters; it is relatively tolerant of turbidity, as long as its prey is plentiful. May become lethargic or moribund when water temperatures drop below 15°C.
TROUT/SALMON			
Rainbow Trout	*Oncorhynchus mykiss*	The majority of rainbow trout found in the Clinch River are stocked by the state of VA in smaller tributaries. Natural reproduction does not occur in the Clinch due to its warmer waters.	Rainbow trout find their way into the Clinch River via colder, smaller tributaries. Can be found in deeper shaded pools during warmer periods, as well as below riffles where they feed on aquatic invertebrates.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
CARP/ MINNOW			
Common Carp	*Cyprinus carpio*	Carp spawn in the spring to early summer, usually during the mornings of sunny days	Typically can be found feeding on or near the substrate.
Spotfin Shiner	*Cyprinella spiloptera*	Spotfin shiners spawn in crevices between rocks or in bark on submerged fallen trees. Spawning takes place throughout the warmer months of the year starting in late May or early June.	Feeds mainly in the late afternoon and early evening. Typically found near riffles with sand, gravel, mud, or rubble substrates.
Striped Shiner	*Luxilus chrysocephalus*	Consumes a wide variety of terrestrial and aquatic insects in the fall and a large quantity of filamentous algae during the winter. Spring spawn in large schools at top or bottom of riffles.	After spawning adults return to deeper pools where they spend most of their time. Once young hatch they spend most of their time near the edge of pools in shallow water. Both adults and juveniles prefer clean gravel and sand substrates.
Rosyside Dace	*Clinostomus funduloides*	Spawn in groups in late April through May. Utilize nests of other fishes /just above or below riffles in course sand or fine gravel.	Intolerant of turbidity and silt, attracted to deep pools, typically with abundant woody debris. Also primarily found in forested watersheds.
Speckled Chub	*Macrhybopsis aestivalis*	Spawn during the spring and summer, typically in smaller streams. There is limited literature on this species reproduction habits.	Found in shallow sandy areas where they feed on aquatic invertebrates.
Bigeye Chub	*Hybopsis amblops*	Spawn in late spring and early summer, little is known about how or where spawning takes place.	Highly intolerant of murky water and silt covered bottoms. Can be found in sandy substrates where they feed on aquatic invertebrates.
Streamline Chub	*Erimystac dissimilis*	Spawn in spring and early summer, little known about their reproductive biology.	Indicator of good water quality in medium to large rivers. Found in areas if swift current above or below a riffle. Often feed in 1-4 ft. of water on aquatic invertebrates.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
Highland Shiner	*Notropis micropteryx*	Spawn during spring and early summer, thought to spawn in riffle habitat. Eggs sink and stick to the substrate.	Found typically in swift clear water with clean gravel or rubble, typically near riffles. Young eat mostly diatoms and algae, adults feed on aquatic invertebrates.
Western Blacknose Dace	*Rhinichthys obtusus*	Spawn during spring and early summer in shallow gravel riffles. Most spawn at 2 years of age.	Found in clear waters with clean substrates of sand, gravel, and cobble. Can typically be found in fast waters with undercut banks and cover. Feed on insect larvae and other invertebrates.
Blotched Chub	*Erimystax insignis*	Spawns in late spring to early summer, non-migrant.	Inhabits rocky riffles, runs, and pools. Most often found above and below riffles.
River Chub	*Nocomis micropogon*	River chubs spawn in April and May. The males select spawning sites with gravel substrate in riffles often adjacent to or just behind a large boulder. Males cover eggs with stones.	Benthic omnivore consuming a variety of invertebrates and plants. There is less food in the stomach of river chubs during the summer. This has been attributed to their tight schooling behavior during this period.
Popeye Shiner	*Notropis ariommus*	Spawn in spring and early summer, however little is known about their reproductive activities or requirements.	Require extremely clear waters, can be found in slow pools where they feed on aquatic invertebrates.
Silver Shiner	*Notropis photogenis*	Silver shiners spawn in June through July by scattering their eggs over gravel riffles.	Can typically be found in or at the tail end of deep swift riffles of cobble and boulders.
Rosyface Shiner	*Notropis rubellus*	Rosyface shiners spawn in May typically over the pebble mound nests of river and hornyhead chubs. Often large schools of rosyface shiners and other small minnows will congregate over a single chub nest. Eggs sink and stick to substrate.	Typically found in swift flowing water with a sand, gravel, or rock substrate. They are intolerant of streams with consistently turbid (murky) waters.
Warpaint Shiner	*Luxilus coccogenis*	Spawns in riffles and rapid areas early June to mid-July. Non-migrant.	Typically found in the upper to mid-levels of the water column over large boulders and gravel where they feed on aquatic invertebrates.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
Whitetail Shiner	*Cyprinella galactura*	Spawns in late May to June at 24-28°C, sexually mature by age 2, males guard territories around the nest, eggs laid between sticks and logs. Non-migrant.	Found in benthic areas of moderate gradient rivers in both pools and riffle habitats. Prefer gravel and rocky substrates. Feed on aquatic invertebrates by sight.
Telescope Shiner	*Notropis telescopus*	Spawns during the spring and early summer, Non-migrant.	Typically found in runs or flowing pools near riffles with gravel or rocky bottoms.
Mimic Shiner	*Notropis volucellus*	Spawn in late spring and early summer, scatter eggs over sand or gravel substrate.	Found in areas with little to no current with some vegetation. Also commonly found in calm sandy areas, typically foraging on aquatic invertebrates.
Steelcolor Shiner	*Cyprinella wipplei*	Spawns in late spring and summer near submerged logs and vegetation, typically near a riffle, eggs are attached to submerged cover. Non-migrant.	Found in runs, pools, and backwaters of moderate gradient rivers and streams that are predominantly clear. Feeds on aquatic insects. Often school near the top and middle of the water column.
Sawfin Shiner	*Notropis sp.*	Spawn from mid-May to early July, sometimes form moderately sized schools. Non-migrant.	Found in benthic habitats, typically clear flowing pools and backwater. Feed on aquatic insects, beetles, and mayflies.
Stargazing Minnow	*Phenacobius uranops*	Spawns in May and June, sexually mature in 1 year.	Found in moderately gradient riffles, clear waters. Young found in clear shallows with sand, Adults typically found over very slightly silted gravel and small to medium rubbles. Adults feed in groups of 10-20 individuals.
Tennessee Shiner	*Notropis leuciodus*	Spawn in spring and summer 17-25°C over other *cyprinidae* nests, non-migrant.	Found in moderate gradient riffles, pools, and runs. Clear waters, with gravel and rubble substrates.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
Creek Chub	*Semotilus atromaculatus*	Creek chubs migrate up smaller streams in early spring when water temperatures reach 55°F to spawn. The males select spawning sites in small streams in smooth water with gravel substrate just above or below a riffle.	During the day creek chubs feed on terrestrial insects, and at night they eat predominately aquatic invertebrates. Tend to feed equally on benthos and drift. Young fish feed during the day while larger individuals feed at night.
Central Stoneroller	*Campostoma anomalum*	In the fall, winter, and spring its diet consist mainly of nonmotile diatoms, but a lot of green algae is consumed in the summer.	Estimated home range of the fish in autumn was determined to be 35.2 + 14.1 m; no individual moved more than 135 m (Mundahl and Ingersoll 1989) The young frequent shoreline areas where the current is slower.
Bluntnose Minnow	*Pimephales notatus*	Bluntnose minnows spawn repeatedly starting in May and continue into August. Males select the spawning site, usually under logs, branches or rocks in shallow water. They will also use artificial spawning sites in old tiles or pipes, migration up smaller streams is not uncommon.	Can be found in shallow areas of clear water were they feed on algae, aquatic insects larvae, diatoms, small crustaceans, and other invertebrates.
SUCKER			
Smallmouth Redhorse**	*Moxostoma breviceps*	Spawn in April and May at night near the top and bottom ends of shallow riffles.	Can be found in shallow water and swift currents as well as areas with clean sand or gravel substrates. Feed on invertebrates. Intolerant of pollution and turbid water.
Northern Hog Sucker	*Hypentelium nigricans*	Hog suckers spawn in April or early May. Young are often found at the edge of pools over a sandy substrate. Like most suckers, they often migrate long distances' to spawn in smaller streams in spring.	Prefer the fast flowing riffles during most of the year but are found in pools during the colder months.
Silver Redhorse	*Moxostoma anisurum*	Spawn in April and May. Migrate into smaller streams and spawn at night at the top and bottom ends of shallow riffles.	Typically found in deep slow pools and is often found over a sand substrate.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
River Redhorse	*Moxostoma carinatum*	Barriers effective at limiting upstream migration, however migration into smaller streams still occurs where redhorse spawn at night at the top and bottom ends of shallow riffles.	They are typically found in deep pools with moderate current over bedrock or gravel substrate.
Shorthhead Redhorse**	*Moxostoma macrolepidotum*	See Smallmouth Redhorse (Found in Lake Erie drainage)	See Smallmouth Redhorse (Found in Lake Erie drainage)
Black Redhorse	*Moxostoma duquesnei*	Barriers effective at limiting upstream migration, however migration into smaller streams still occurs where redhorse spawn at night at the top and bottom ends of shallow riffles.	Inhabit swift-flowing waters. Preferred substrates include gravel, bedrock, or sand. Young redhorses feed in schools near emergent aquatic vegetation close to the edge of pools. Adult black redhorses usually feed in schools just above or below a riffle moving slowly over the bottom.
Golden Redhorse	*Moxostoma erythrurum*	Make large migrations from larger rivers and reservoirs to smaller streams where they spawn at night in shallow riffles.	Spend much of the day and some of the nights in lager pools, feeding intensifies at daybreak and dusk. Feeds on benthic aquatic insects.
White Sucker	*Catastomus commersoni*	White suckers spawn from April to early May when they run upstream, usually starting at night. They seek areas with swift water and a gravel substrate to randomly spread their eggs. Migrations commence when water temperatures approach 10°C.	White suckers are very tolerant of pollution, turbidity (murky water), and low oxygen levels - can be found in many habitats.
CATFISH			
Channel Catfish	*Ictalurus punctatus*	Move into shallows or tributaries to spawn. Begin spawning when water temperatures reach 70°F. They use natural cavities, undercut banks and as nests.	Prefer areas with deep water, clean gravel or boulder substrates, and low to moderate current. Tendency to move toward shallow waters at dusk where they feed.
Flathead Catfish	*Pylodictis olivaris*	They build nests in dark secluded shelters such as natural cavities, undercut banks, or near large, submerged objects.	Adults prefer deep pools with slow current and cover, such as submerged logs and brush piles.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
Yellow Bullhead	*Ameiurus natalis*	They build nests in secluded shelters such as natural cavities, undercut banks, or near large, submerged objects. Young are guarded by the male several weeks.	Can be found in clear water with dense aquatic vegetation where they feed on other fish and aquatic insects.
Mountain Madtom	*Noturus eleutherus*	Spawn in early summer under large rocks within riffles, males guard eggs.	Found in deep swift riffles usually around cobbles and boulders where they feed on aquatic invertebrates.
SCULPIN			
Clinch Sculpin	*Cottus sp.*	Generally spawn once a year in winter, spring, or cool boreal summer. Nest sites are small cavities under rocks, logs, and divers other structures that are guarded by the male.	Found in cool swift water in Virginia. They inhabit spring runs, creeks, and streams that typically are clear year-round and cold to cool in summer. Sculpins lie on the bottom and ambush approaching prey.
SUNFISH			
Rock Bass	*Ambloplites rupestris*	Spring spawners - Male rock bass build nests over gravel substrate in a slight current often next to a large boulder.	Rock bass prefer clear streams and rivers with a rocky bottom. They often hide near large boulders, rock piles, or tree roots. Also look for them near steep drop offs at the edge of deep pools.
Bluegill	*Lepomis macrochirus*	Bluegill typically build nests in large groups, or colonies. They spawn multiple times between May and August. Peak spawning, in Ohio, usually occurs in June. Males select an area in one to four feet of water and sweep out a saucer shaped nest with their tails.	Most commonly found in clear waters with bank cover and aquatic vegetation.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
Green Sunfish	*Lepomis cyanellus*	Green sunfish are communal spawners with males constructing nests in shallow water from mid-May to August. Green sunfish tend to spawn in shallower water, and dig deeper nests than bluegill.	Very tolerant of poor water quality and are often the only sunfish found in very muddy waters. They do have a strong preference to hide around structures such as rocks, logs, or brush piles.
Longear Sunfish	*Lepomis megalotis*	Longear sunfish spawn in groups but do not form large colonies like bluegill. Males select a spawning site in shallow water and build a nest on gravel substrate usually near cover. Longear sunfish spawn multiple times once the water temperature reaches the low 70's between mid-May and mid-August.	They favor slow to moderate flow in clear streams of moderate size with clean gravel substrate. They spend most of their time in pools near beds of aquatic vegetation, or other forms of cover such as roots, brush piles, and undercut banks.
Lepomis Hybrid	-	See Longear sunfish	See Longear Sunfish
Redbreast Sunfish	*Lepomis auritus*	Spawn in spring and summer, males guard the nest, and often guard hatchlings. Non-migrant.	Studies have found less than 200m life time movements during recapture studies. Found in deeper slower areas, rocky and sandy pools. Feed on aquatic invertebrates.
BLACK BASS			
Smallmouth Bass	*Micropterus dolomieu*	Smallmouth bass spawn in May and early June when water temperatures range from 55 to 65°F. Nests are built in gravel or hard bottom substrates in 2 to 20 feet of water.	Smallmouth bass thrive in streams with gravel or rock bottoms with a visible current. Found in benthic areas, adults seek deeper pools during the day.
Largemouth Bass	*Micropterus salmoides*	Largemouth bass usually spawn between mid-April and mid-June. Nests are constructed by the male in 1 to 6 feet of water.	Largemouth bass can adapt to many environments but prefer relatively clear non-flowing waters with some aquatic vegetation. They are found in nearly every lake, reservoir, and pond in Ohio.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
Spotted Bass	*Micropterus punctulatus*	Spotted bass spawn between mid-April and mid-June. The males construct nests over rocky or gravely substrate near cover. They will spawn in deeper water than the other two species of black bass found in VA, sometimes at depths of up to 40 feet.	Preferred habitat is long deep pools of medium to large streams and rivers. They avoid both shallow, heavily vegetated, still, waters preferred by largemouth bass, and the swift flowing rocky waters preferred by smallmouth bass.
DARTER			
* Moves into shallow waters at night (Trautman,1981)			
Greenside Darter	*Etheostoma blennioides*	Adults spawn in deep, fast flowing riffles in April when water temperatures are between 55 and 65°F. The eggs are attached to strands of filamentous algae and aquatic moss.	(*) occurs in varied habitats; often in medium to large streams and small to medium rivers with gravel and rubble riffle habitat. Avoids silt.
Ashy Darter	*Etheostoma cinereum*	Spawns from late January to early April, non-migratory.	Found in benthic areas above and below riffles, found in shallow waters, (0.05-2 meters) with litter current over clear gravel and rubble. Feed on aquatic invertebrates.
Speckled Darter	*Etheostoma stigmaeum*	Spawns in April and May. Eggs hatch in 9-10 days at 17-20^{o}C, eggs laid in gravel over riffles, Non-migrant.	Found in clear sandy and rocky pools with moderate gradients and fast water. Feed on aquatic invertebrates.
Redline Darter	*Etheostoma rufilineatum*	The river darter may move upstream to spawn in the spring (Trautman 1981, Shultz 1986).	Adults are usually only found in shallow areas at night, or when turbidity is high (Becker 1983).
Snubnose Darter	*Etheostoma simoterum*	Not much known on spawning habits, thought to spawn in early spring and summer. Non-migrant	Found in current-swept rocky pools and adjacent riffles.
Bluebreast Darter	*Etheostoma camurum*	Spawn in mid-May - late July. They bury their eggs in gravel in fast flowing riffles, spawning typically requires migration into smaller streams. Eggs hatch in 7-10 days at 19-23^{o}C	Typically found in clear or slightly turbid water with moderate gradient, moderately swift runs and riffles with substrates of coarse gravel, rubble, or boulders

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
Fantail Darter	*Etheostoma flabellare*	Spawn on the underside of flat rocks in the spring, males guard eggs – hatch in 30-35 days at 17-20^{o}C. Migrate downstream to deeper waters during winter months in some areas.	(*) Most abundant in medium to small streams in the range of 20 to 40 feet wide. Found in riffles with gravel substrates. Feed on immature aquatic insects.
Blotchside logperch	*Percina burtoni*	Spawns from April - June with water temps around 19^{o}C. Non-migrant. Avoids turbid waters and silty substrates.	Found in moderately gradient systems within the riffle, run, and pool habitats, at or near the bottom. Eats primarily benthic invertebrates.
Johnny Darter	*Etheostoma nigrum*	Spawn on the underside of flat rocks in the spring – spawning often involves migration into smaller tributaries – considerable upstream and downstream movements may precede spawning	Inhabits streams and rivers of all sizes where it is found in pools and other slack water habitats on sand and gravel substrates.
Tippecanoe Darter	*Etheostoma tippicanoe*	Spawn in late spring and early summer when temperatures reach the upper to mid-20s , males guard eggs,	Found in shallow riffles and swift runs, typically in clear waters.
Wounded Darter	*Etheostoma vulneratum*	Spawn in spring and summer. Not much is known about the reproductive biology of this species has a very limited range across 4 states.	Habitats include fast rocky riffles of small to medium rivers.
Banded Darter	*Etheostoma zonale*	Banded darters spawn from mid-April to mid-May and sometimes as late as July, in swift riffles.	Banded darters can be found in streams of all sizes from small creeks to large rivers in rocky riffle habitats. Feeding activity peaks at midday.
Tangerine Darter	*Percina aurantiaca*	Spawns in May to June. Females breed between 2-4 years. of age. Live to be just over 4 years. Spawning likely occurs in sand and gravel riffles with moderate to swift currents.	Found in clear creeks and smaller river with moderate to steep gradients. Adults most often found in deeper, swift flowing runs and rapids near boulders. Juveniles more likely to be found in pools and slow runs with gravel substrates.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
Gilt Darter	*Percina evides*	Spawn in May at 17-20°C in Virginia. Spawns only twice in its lifetime.	Found in clear rivers and streams with silt-free bottoms and permanently strong flow. Typically in moderate to fast deep riffles and pools over gravel, rubble, and small boulders.
Dusky Darter	*Percina sciera*	Spawns in late May to early July over loose gravel at depths of 30-90 cm - males and females mature in 1 yr. Make seasonal migrations between smaller tributaries in warm seasons and deeper downstream winter habitats in some past studies.	Found in benthic areas, fast runs and sometimes riffles. Mostly over course clean gravel at depths of 20 cm or more in spring and early summer.
Logperch	*Percina caprodes*	Spawn in mid-March to mid-May, a few hundred males gather in schools then females join a single male where they partially bury themselves in sand where the eggs are laid – hatch in 5-8 days. Move from deeper water to shallows to spawn.	Found in clean riffles and runs over substrates of mixed sand and gravel. Often associated with bottom debris. Young often found in dense beds of vegetation. Eats primarily benthic invertebrates. Typically inactive at night, stay on the bottom.
PERCH			
Walleye	*Sander vitreus*	Spawn throughout the month of April when water temperatures are between 40 and 55°F - Typically migrate to riffle areas to spawn, however many are stocked by the state of VA as fingerlings.	Usually associated with large rivers and lakes, where they congregate near the bottom during the day, and move into the shallows at night to feed.

Common Name	Scientific Name	Seasonal Activities/ Spawning Migration	Daily Activities/ Migration/ Habitat
Sauger	*Sander canadensis*	Growth rates and daily rations were highest between September and January and lowest between March through August. Spawn over 2 week period in the spring. Eggs hatch in 3-4 weeks at 5-15^{o}C. Typically move little in the summer but movements of as far as 100 have been recorded in the Mississippi.	Found in sand and gravel runs, sandy and muddy pools and backwaters. Moves into shallow waters at night (Trautman 1981). Period activity increases in more turbid water.

Source: (Becker 1983); (Simon 1999); (Ohio DNR); (Stauffer et al., 1995); (Trautman 1957); (Robins et al., 1991); (Jenkins & Burkhead 1993); (explorer.natureserve.org)
Note: (**) The Shorthead and Smallmouth Redhorse have been separated by drainages.

4.6 Identification of Threatened, Endangered, and Other Protected Species Susceptible to I & E at CWIS [§ 122.21(r)(4)(vi)]

There are 13 fish species that are listed as threatened or endangered Federally or at the state level (Table 4-7). Summaries of Federally-listed species were available at the county level, but state-listed species were not, so Table 4-7 is overly inclusive. Nine (9) of these fish are unlikely to be found near the Clinch River Plant as there are no records of their observation in Russell County and/or the species are not found in that section of the Clinch River. Of the four remaining fish species in Table 4-7, one, the Sickle Darter, has the potential to be found in the area as there are records of it in this section of the Clinch River, however it seems to be rarely observed, while the Yellowfin Madtom, Steelcolor Shiner, and the Golden Darter have records of recent observance. In previous surveys conducted on the Clinch River near the facility the Golden Darter[1] and the Steelcolor Shiner have been collected, although in very low abundances. The Golden Darter is listed as a Federal Species of Concern (SOC) and is State Threatened and the Steelcolor Shiner is State Threatened. Both of these species have low potential for entrainment in early life stages. None of these species are likely to be impinged or entrained due to the low through-screen velocity associated with the facility. The Yellowfin Madtom, which is Federally and state threatened was recently found to have a “pretty good population” spanning 15 miles of river centered on Cleveland, VA (Shute, 2004).

The Clinch River has been described as having one of the most diverse mussel and fish faunas of any comparably-sized stream in North America (Neves 1991). Currently, of the 81 freshwater mussel species recognized in Virginia, 37 are listed as threatened or endangered, with 32 occurring in the Clinch, Powell, and Holston river watersheds of Virginia’s upper Tennessee River drainage. However, even with improvements in water quality since the Clean Water Act, mussel populations have continued to decline especially in the upper reaches of the Clinch River. There are 21 unionid species that are classified as threatened, endangered or protected at the state and Federal levels upstream and downstream of the Clinch River Plant (Table 4-8).

The Virginia Wildlife Action Plan (WAP) identifies 925 species of greatest conservation need, 60% of which are aquatic, 70% of which are invertebrates. These species are grouped into four tiers of relative conservation need: critical (I), very high (II), high (III), and moderate (IV) conservation need. These tiers allow for prioritization of threats facing species and of conservation actions addressing those threats. The action plan is a 10-year strategic plan that is required for continued funding through the State Wildlife Grant Program. There are 89 aquatic mollusk species on the current tiered list of Species of Greatest Conservation Need, 57 of which are unionid species. The 21 protected species listed on Table 4-8 are included in this tiered list.

Table 4-7. Federal and State Threatened and Endangered Fish Species and Species of Concern with the Potential to Occur within the vicinity of Clinch River Plant CWIS

Common Name	Scientific Name	Status	Potential to Occur in the Vicinity of the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles***
Blackside Dace	*Chrosomus cumberlandensis*	FT, ST	Unlikely – prefers small upland tributaries. Only records in VA are a small tributary of the Powell River	Unlikely	Unlikely
Duskytail Darter	*Etheostoma percnurum*	FE, SE	Unlikely– only found in Copper Creek, a tributary of Clinch River. One specimen recorded in the Clinch River in 1980 at Speers Ferry	Unlikely	Unlikely
Emerald Shiner	*Notropis atherinoides*	ST	Unlikely*	Unlikely	Unlikely
Golden Darter**	*Etheostoma denoncourti*	SOC, ST	Likely	Unlikely	Unlikely
Paddlefish	*Polyodon spathula*	ST	Unlikely – closest record in the Clinch River near Dungannon in the '80's	Unlikely	Unlikely
Sickle Darter	*Percina williamsi*	ST	Potential	Unlikely	Unlikely
Slender Chub	*Erimystax cahni*	FT, ST	Unlikely* - Not seen in the Clinch River since 1967	Unlikely	Unlikely
Spotfin Chub	*Erimonax monachus*	FT, ST	Unlikely* – Not seen in the Clinch River since 1893	Unlikely	Unlikely
Steelcolor Shiner	*Cyprinella whipplei*	ST	Likely – found in AEP surveys in "84, '87, and 90	Unlikely	Unlikely

Common Name	Scientific Name	Status	Potential to Occur in the Vicinity of the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles***
Tennessee Dace	*Chrosomus tennesseenisis*	SE	Unlikely* – no records in Clinch	Unlikely	Unlikely
Variegate Darter	*Etheostoma variatum*	SE	Unlikely – very rare in Virginia, no records in the Clinch or its watershed	Unlikely	Unlikely
Western Sand Darter	*Ammocrypta clara*	ST	Unlikely*	Unlikely	Unlikely
Yellowfin Madtom	*Noturus flavipinnis*	FT, ST	Likely	Unlikely	Unlikely

Note:

FE=Federally Endangered, SOC=Federal Species of Concern, SE=State Endangered, ST=State Threatened, SSC=State Species of Concern.

*These species are recorded as being extirpated/possibly extirpated from the watershed. (NatureServe.org) / suitable habitat unlikely available for these species
**This species designation was recently split from the Tippecanoe darter. The species are separated by drainages. See note on Table 4-1.
***Potential for Impingement of Juveniles and Adults assumed to be unlikely for all species due to small AOI and through-screen velocities that will be less than 0.5 fps at normal water level after shutdown of Unit 3 in May 2015.

Potential – Record of observation exist but very rare;
Likely – Presence recorded;
Unlikely – No records in that county or that section of the Clinch River, may be found in the watershed.

In 2002, the Virginia Department of Game and Inland Fisheries (VDGIF) developed a strategy to restore freshwater mussels at six reaches within the upper Tennessee River drainage. These reaches include four on the Clinch River, and one site each on the Powell and North Fork Holston rivers. This mussel restoration strategy includes four levels of introduction: augmentation, expansion, reintroduction and establishment. These levels have been defined by the National Strategy for the Conservation of Native Freshwater Mussels (NSCNFM) (NNMCC 1998) and the Upper Tennessee Mollusk Recovery Group (UTMRG). The UTMRG is comprised of representatives from the Virginia Department of Game and Inland Fisheries (VDGIF), Virginia Polytechnic Institute and State University, U.S. Geological Survey, U.S. Fish and Wildlife Service, and The Nature Conservancy (VDGIF 2010). The main restoration technique, augmentation, was to release translocated adults or propagated juveniles into reaches where valid species records exist since at least 1980 (VDGIF 2005). The overall goal is to develop self-sustaining mussel populations with a goal of delisting. Almost 400,000 mussels of 11 species have been released as a result of these efforts. DGIF's efforts have enhanced mussel presence in the plant vicinity, and these species have been included in the assessment of potential impingement/entrainment impacts.

Reach number 4 of the mussel augmentation includes approximately 12 river miles starting from Nash Ford to Carbo. American Electric Power's Clinch River Plant is located within this reach for mussel augmentation. Sixteen of the 21 species found near Clinch River Plant are being augmented to this stretch of river with some of the species being non-listed species (Table 4-8 summarizes the augmentation of listed species).

The majority of freshwater mussels use juvenile and adult fish as a means for population dispersal. Many mussel species have a wide variety of fish hosts they can use to infest with glochidia but there are a few that are limited to one or two hosts according to laboratory transformations of larvae into juvenile mussels. Many of these host-fish/mussel relationships are still unknown. However, in a natural situation, glochidia will attach to almost any fish including those that are not suitable hosts.

Regarding potential entrainment impacts to protected mussel species at the Clinch River Plant, it is important to note that early life stage fish are not typically host fish for glochidea and therefore the potential for entrainment of glochidea infested host fish is negligible. Similarly, potential impingement of glochidea infested host fish is also negligible primarily due to the low through screen velocities at the intake, particularly after retirement of Unit 3. Additionally, given that several other factors (i.e., use of closed cycle cooling, flow reduction, and use of a low fraction of the Clinch River flow) contribute to the cooling system of the Clinch River Plant being protective of fish, impacts to protected mussels species is not expected to occur (Table 4-8).

There are 3 federally-listed non-aquatic species found near Clinch River Plant (see Table 4-9). Bats generally forage on flying prey/insects and not fish or macroinvertebrates in the water body, thus they are unlikely to be affected by impingement or entrainment.

Table 4-8. Federal and State Threatened and Endangered Mussel Species and Species of Concern with the Potential to Occur within the vicinity of Clinch River Plant CWIS

Common Name	Scientific Name	Status	WAP Tier	Host Fish	Species Augmented in Reach 4	Any Host Fish Susceptible to Impingement**
Appalachian Monkeyface	*Quadrula sparsa*	SE	I	Hosts unknown	Yes	Unlikely
Black Sandshell	*Ligumia recta*	ST	III	Central Stoneroller, Largemouth Bass, Bluegill, Sauger, Yellow Perch	Yes	Unlikely
Birdwing Pearlymussel	*Lemiox rimosus*	FE	I	Snubnose Darter and Greenside Darter	Yes	Unlikely
Crackling Pearlymussel	*Hemistena lata*	SE, FE	I	Banded Sculpin, Central Stoneroller, Whitetail Shiner, Fantail Darter, Streamline Chub	Yes	Unlikely
Cumberland Combshell	*Epioblasma brevidens*	SE, FE	I	Banded Sculpin, Black Sculpin, Fantail Darter, Greenside Darter, Spotted Darter, Redline Darter, Snubnose Darter, Roanoke Darter, Logperch	Yes	Unlikely
Cumberland Monkeyface	*Quadrula intermedia*	FE	I	Streamline Chub and Blotched Chub	Yes	Unlikely
Deertoe	*Truncilla truncata*	SE	IV	Freshwater Drum and Sauger	No	Unlikely
Dromedary Pearlymussel	*Dromus dromas*	SE, FE	I	Black Sculpin, Channel Darter, Fantail Darter, Greenside Darter, Gilt Darter, Tangerine Darter, Blotchside Darter, Roanoke Darter, Logperch	Yes	Unlikely
Fine-rayed Pigtoe	*Fusconaia cuneolus*	SE, FE	I	Bluntnose Minnow, Central Stoneroller, River Chub, Whitetail Shiner	Yes	Unlikely
Fragile Papershell	*Leptodea fragilis*	ST	IV	Freshwater Drum	No	Unlikely
Longsolid	*Fusconaia subrotunda*	SOC	III	Hosts unknown	Yes	Unlikely

Common Name	Scientific Name	Status	WAP Tier	Host Fish	Species Augmented in Reach 4	Any Host Fish Susceptible to Impingement**
Ohio Pigtoe	*Pleurobema cordatum*	SE	III	Creek Chub, Bluegill, Brook Stickleback, Guppy	No	Unlikely
Oyster Mussel	*Epioblasma capsaeformis*	FE	I	Greenside Darter, Bluebreast Darter, Fantail Darter, Redline Darter, Snubnose Darter, Wounded Darter, Dusky Darter, Black Sculpin, Mottled Sculpin, Banded Sculpin	Yes	Unlikely
Purple Bean	*Villosa perpurpurea*	SE, FE	I	Hosts unknown	Yes	Unlikely
Rayed Bean	*Villosa fabilis*	SOC	II	Greenside Darter, Mottled Sculpin, Largemouth Bass	No	Unlikely
Rough Rabbitsfoot	*Quadrula c. strigillata*	SE, FE	I	Whitetail Shiner, Bigeye Chub	Yes	Unlikely
Shiny Pigtoe	*Fusconaia cor*	SE, FE	I	Common Shiner, Whitetail Shiner, Redline Darter	Yes	Unlikely
Slabside Pearlymussel	*Lexingtonia dolabelloides*	ST	II	Shiners	Yes	Unlikely
Tennessee Clubshell	*Pleurobema oviforme*	SOC	III	Central Stoneroller, River Chub, Common Shiner, Whitetail Shiner, Tennessee Shiner, Telescope Shiner and Fantail Darter	Yes	Unlikely
Tennessee Heelsplitter	*Lasmigona holstonia*	ST	II	Banded Sculpin, Redline Darter, Snubnose Darter, Bluntnose Minnow, Central Stoneroller, Creek Chub	No	Unlikely
Tennessee Pigtoe	*Fusconaia barnesiana*	SSC	II	Hosts unknown	Yes	Unlikely

Note: **Potential for Impingement of Juveniles and Adults assumed to be unlikely for all species due to small AOI and through-screen velocities that will be less than 0.5 fps at normal water level after shutdown of Unit 3 in May 2015.

Table 4-9. Remaining Federally-listed Species (non-fish and non-shellfish) with the Potential to Occur within the Vicinity of Clinch River Plant CWIS

Common Name	Scientific Name	Status	Potential to Occur in the Vicinity of the Intake	Potential for Entrainment	Potential for Impingement
Indiana bat	*Myotis sodalis*	FE	Possible – within range	Unlikely	Unlikely
Gray Bat	*Myotis grisecens*	FE	Possible – within range	Unlikely	Unlikely
Northern Long-Eared Bat	*Myotis septentrionalis*	FT	Possible – within range	Unlikely	Unlikely

Note: FE=Federally Endangered, FT = Federally Threatened.

4.7 Documentation of Consultation with Services [§ 122.21(r)(4)(vii)]

There have been neither public participation, nor coordination undertaken with U.S. Fish and Wildlife Services or Virginia Department of Game and Inland Fisheries.

4.8 Methods and QA Procedures for Field Efforts [§ 122.21(r)(4)(viii)]

AEP is not relying upon any new data it collected to support the biological baseline characterization; therefore, there is no need to document methods and QA procedures for historical studies in this subsection.

4.9 Definition of Source Water Baseline Biological Characterization Data [§ 122.21(r)(4)(ix)]

AEP acknowledges that the final rule adds three additional subsections to the requirements of § 122.21(r)(4). While AEP has provided data to address § 122.21(r)(4)(i) – (viii) and (x) – (xii), there is no required submittal under this sub-section § 122.21(r)(4)(ix).

4.10 Identification of Protective Measures and Stabilization Activities [§ 122.21(r)(4)(x)]

AEP is not aware of any measures or stabilization activities that have been pursued in the Clinch River near the Clinch River Plant that might affect either the relevance of historical data or attempt to restore any impingement or entrainment losses. On the other hand, the design of the cooling water system (i.e., use of closed cycle cooling) and the cooling water intake (i.e., through-screen velocity of less than 0.5 fps on normal pool level conditions) reduce the rates of impingement and entrainment.

4.11 List of Fragile Species [§ 122.21(r)(4)(xi)]

In the final 316(b) Rule, EPA identifies 14 species as fragile or having post-impingement survival rates of less than 30 percent, including:

- Alewife
- American Shad
- Atlantic Herring
- Bay Anchovy
- Blueback Herring
- Bluefish
- Butterfish
- Gizzard Shad
- Grey Snapper

- Hickory Shad
- Menhaden
- Rainbow Smelt
- Round Herring
- Silver Anchovy

Of these species only gizzard shad inhabits the Clinch River and is likely to be present near the intake.

Gizzard shad are represented in the Clinch River among the species most likely to be vulnerable to entrainment. Gizzard Shad spend most of their adult life in large schools where they filter feed on both phytoplankton and zooplankton. Gizzard Shad of all ages are extremely fragile, and handling them or keeping them in captivity for controlled laboratory testing is difficult even under the best of circumstances (Shoemaker 1942; Bodola 1965; Reutter and Herdendorf 1974). Conditions for Gizzard Shad populations are optimal in warm, fertile, shallow bodies of water with soft mud bottoms, high turbidity, and relatively few predators (Miller 1960; Zeller and Wyatt 1967). In fact, lacustrine habitats with these characteristics are the most likely to become overpopulated with Gizzard Shad. Factors contributing to this problem are the Gizzard Shad's high reproductive capacity, rapid growth rate, and efficient and direct use of plankton (Hubbs 1934; Miller 1960; Bodola 1965). While their life span is three to eleven years, few live beyond age three. In general, short life spans are correlated with rapid growth rates in the first year of life. In more northern parts of its range, Gizzard Shad typically live to ages 5 to 7 and may live to ages 10 or 11 (Miller 1960; Jester and Jensen 1972).

4.12 Information Submitted to Obtain Incidental Take Exemption or Authorization from Services [§ 122.21(r)(4)(xii)]

The Clinch River Plant has not sought or obtained an incidental take exemption or authorization for its cooling water intake structure from the U.S. Fish and Wildlife Service.

5 Cooling Water System Data [§122.21(r)(5)]

5.1 Description of Cooling Water System Operation [§122.21(r)(5)(i)]

The Clinch River Plant circulating water systems are closed-loop systems; that is, the cooling water is recycled and reused in the steam turbine condensers (see Figure 5-1 for Schematic of Units 1 and 2 Circulating Water System). The plant currently has two generating units; Unit 3 was permanently retired in May 2015. The circulating water systems for Units 1 and 2 are identical for the purposes of this description. The normal requirement of circulating water for Units 1 and 2 is 220,000 GPM, and four cooling towers are used to cool the circulating water for reuse. Approximately 65% of the design intake flow is used for cooling (see Figure 3-4 under Section 3.4 for Water Balance Diagram of Current Operation at Clinch River Plant). Clinch River Plant cooling water is not used in any manufacturing process either before or after it is used for cooling[2].

Monthly water withdrawals from the Clinch River expressed as a percent of the low flow[3] and mean flow conditions relative to actual average monthly intake flow prior to Unit 3 retirement for a period from 2010 to 2013 and current design intake flow of 9.36 MGD after the retirement of Unit 3 are shown in Table 5-1. The plant design intake withdrawal (9.36 MGD) during low-flow conditions in the March-July peak larval density period is estimated at 2.6-13.1% of the low river flows (95% exceedance flows) and 1.0-4.2% of mean monthly flows. Additionally, the water withdrawn is not totally consumed by the plant, i.e., approximately one third of the water withdrawn is returned to the river, resulting in less than 15% of the river being consumed during critical low flow events based on the lowest 95% exceedance flow in October (Table 5-1). The design maximum through-screen velocity is estimated to be 0.5 fps and 0.2 fps at the low water depth of 4 ft and normal pool level of 14 ft, respectively (see Appendix B for engineering calculations of through-screen velocities). Therefore, the withdrawal by Clinch River Plant should not impact downstream aquatic life, recreation, water supply, and other water uses.

Clinch River Plant is used for base-load generation and runs 24 hours a day, seven days a week; therefore, the cooling water intake structure is operating 24 hours a day to meet the facility’s cooling demands. Seasonal variations of Clinch River Plant cooling water system operation also coincides with those of the intake structure operation. Based on the daily intake flow data from 2010 to 2013, minimum makeup water demand occurs in April due to lower demand, cooler temperatures and humidity, and scheduled maintenance shutdowns. Maximum water demand occurs in July when the demand for electricity is greatest and higher temperatures and high relative humidity result in a decline in cooling efficiency.

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[2] It is also noted that the facility is fairly isolated, such that no nearby alternative water sources (e.g., reclaimed wastewater, grey water) are available. Groundwater and public water supply resources are also inadequate to provide an alternative cooling water source for this facility.

[3] Low flow conditions are expressed as 95% exceedance flows (i.e., 95% of flow values are above the value provided).

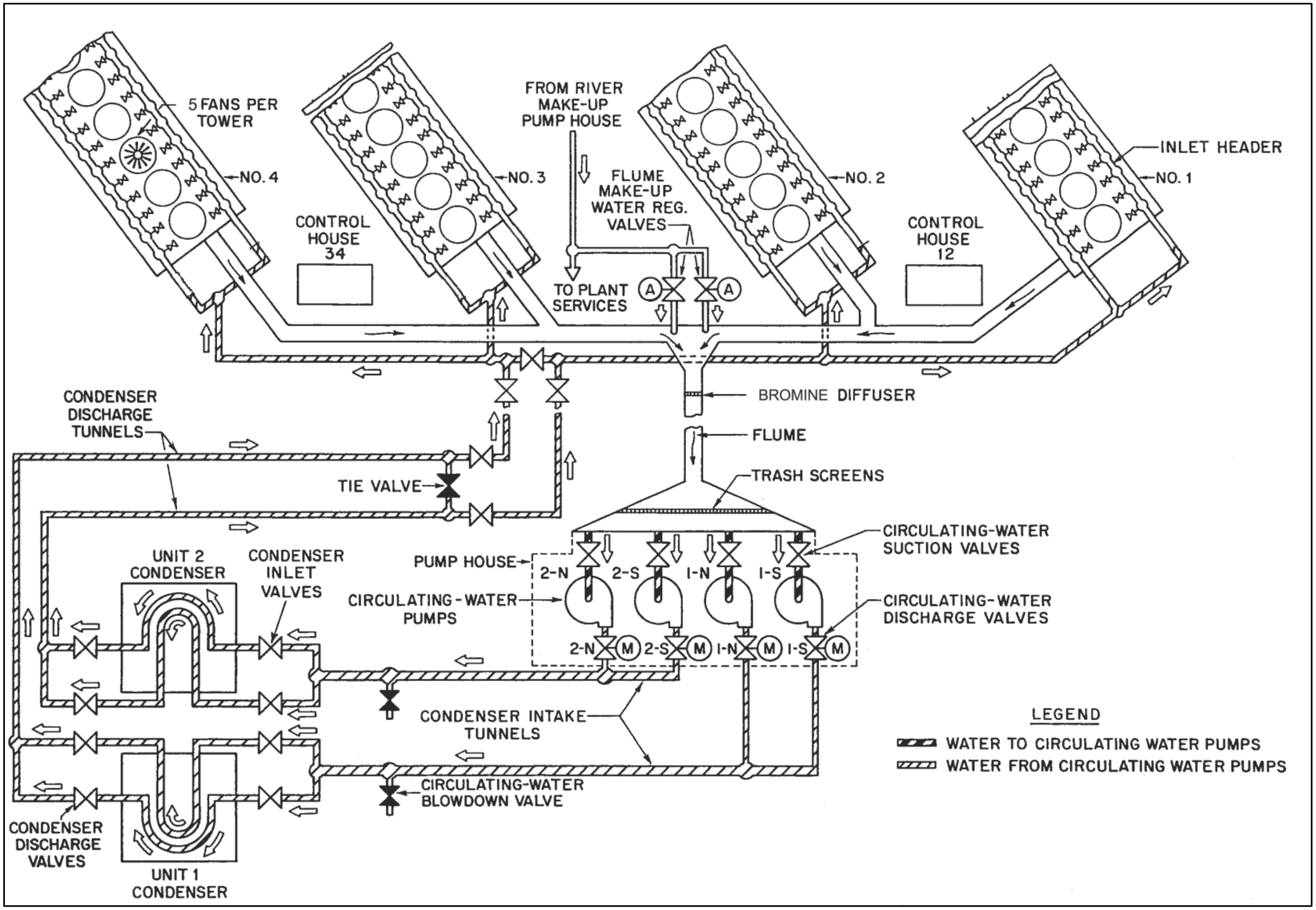

Figure 5-1. Units 1 and 2 Circulating Water System of Clinch River Plant

Table 5-1. Clinch River Plant Withdrawal (Design and Actual) as Percent of Clinch River Flows

Month	Low Flow Condition (95% Exceedance River Flow; MGD)	[1]Monthly Mean River Flow (MGD)	[2]Historical Actual Intake Flow (MGD) Prior to Retirement of Unit 3	Percent Withdrawal Relative To Low River Flow Condition		Percent Withdrawal Relative To Mean River Flow Condition	
				Historical Actual Intake Flow Prior to Retirement of Unit 3	Design Flow of 9.36 MGD Post Retirement of Unit 3	Historical Actual Intake Flow Prior to Retirement of Unit 3	Design Flow of 9.36 MGD Post Retirement of Unit 3
Jan	149.2	721.3	8.8	5.9%	6.3%	1.2%	1.3%
Feb	278.5	859.6	10.3	3.7%	3.4%	1.2%	1.1%
Mar	355.1	909.4	9.7	2.7%	2.6%	1.1%	1.0%
Apr	276.3	679.9	7.0	2.5%	3.4%	1.0%	1.4%
May	165.5	510.6	8.6	5.2%	5.7%	1.7%	1.8%
Jun	84.7	319.9	9.9	11.7%	11.1%	3.1%	2.9%
Jul	71.5	221.0	13.7	19.1%	13.1%	6.2%	4.2%
Aug	64.7	208.8	8.9	13.7%	14.5%	4.2%	4.5%
Sep	46.2	142.2	9.3	20.2%	20.3%	6.6%	6.6%
Oct	41.8	170.6	7.9	18.9%	22.4%	4.6%	5.5%
Nov	57.1	269.5	8.6	15.1%	16.4%	3.2%	3.5%
Dec	80.5	512.5	7.4	9.2%	11.6%	1.5%	1.8%

Note:
1. USGS flows at gaging station #03524000 (Clinch River at Cleveland, VA) from water years 1921 to 2015 were used.
2. Historical Actual Intake Flows prior to Retirement of Unit 3 are based on the CWIS operation in 2010-2013; Unit 3 was retired in May 2015.

After passing through the conventional traveling screens (see Section 3.1 for more details), the circulating water flows to the suctions of the circulating water pumps. There are four such pumps, two pumps for each condenser. Each pump is rated at 55,000 GPM, 85 ft. TDH at 390 rpm, and is driven by a 1,500 hp, 4,000 volt motor. The circulating water pumps are controlled from the plant’s main control room. Each pump is equipped with a hand-wheel operated suction valve and a motor-operated discharge valve.

The circulating water pumps discharge into two intake tunnels which supply circulating water to the condensers of Units 1 and 2. From the pump discharge, the water flows into a 72 in. concrete intake tunnel via 42 in. and 54 in. pipes. At the condenser, the 72 in. intake tunnel branches into two 54 in. inlet pipes so as to provide an independent supply of circulating water to each section of the condenser. The two 54 in. inlet pipes join the two condenser water-box inlet nozzles. Each inlet pipe is equipped with a hand-wheel-operated butterfly valve. The circulating water flows through the condenser tubes in the condenser and out via two 54 in. discharge nozzles and pipes. Each discharge pipe is equipped with a hand-wheel-operated butterfly valve. The water then flows into a 72 in. concrete discharge tunnel which leads to the cooling towers. The two 72 in. concrete discharge tunnels run parallel to each other under the basement floor. At the cooling towers, these tunnels sub-divide into 54 in. individual headers. Hand-operated valves are provided in the 72 in. concrete discharge tunnels so as to permit alternate flow from one tunnel to the other in emergencies. These valves will also be used when it becomes necessary to de-water either discharge tunnel.

On Tower 4 only, a 72 in. circulating water intake tunnel is equipped with an 8 in. blowdown valve. The amount of blowdown is determined in accordance with the pH control of the circulating water system. The blowdown is discharged to a sump that feeds into the plant’s advanced wastewater treatment system.

Cooling Towers

Each of the four original 1958-vintage cooling towers for Units 1 and 2 measured 281 ft long, 67 ft wide and 61 ft high. Each of the mechanical draft towers consisted of ten cells with the heat transfer section designed as a cross-flow thermal configuration (e.g. water flows down while air is drawn in horizontally).

Between 1999 and 2002, the four 10-cell cross-flow cooling towers were replaced with four 5-cell counter-flow cooling towers while duplicating the original thermal design basis of each tower cooling 55,000 GPM from 97°F to 78°F at a wet bulb of 70°F. The dimensions of each of the four new five-cell counter-flow towers are 240 ft-8 in. long, 48 ft-8 in. wide and 45 ft high (Figure 5-2). As a result, the new towers fit within the original basins with empty space at the end and along one side.

The transfer of heat from the circulating water to the atmosphere is accomplished in the cooling tower by passing the warm circulating water through a stream of moving air. For maximum air-water contact, the warm water runs down thousands of modules which consist of corrugated polyvinyl chloride (PVC) sheets. This maximizes the water surface area for optimum cooling by the air stream. The air, rising counter flow to the water through the spacing between the sheets, is moved by 150 hp mechanical draft fans (28 ft diameter) discharging air through 14 ft tall fan stacks. The performance of cooling towers varies with wind velocity, humidity and outdoor temperature.

Evaporation accounts for the greatest part of the heat transfer. This effect makes it possible to cool the water below the atmospheric dry-bulb temperature. In evaporating one pound of water, approximately 1,000 Btu's are transferred from the water into the air. The water is also cooled by sensible heat transfer to the air.

The evaporation process results in a loss of water from the closed circulating water system. This loss is replaced by the river make-up system. When water is removed by the evaporation process, no dissolved solids are removed. As a result, the circulating water would contain more solids than can remain in solution, causing scaling and fouling of the system components (e.g., heat exchanger equipment - condensers, coolers). In order to prevent this scaling and fouling of the system, blowdown is required. The circulating water system for each Unit is currently run at two to five cycles of concentration before the blowdown. The plant chemist determines the required blowdown by test because the amount of solids in the river water is variable. This determination serves to minimize the amount of makeup water required. After the boilers are converted from coal to natural gas firing by late 2016, the circulating water system will run around five cycles of concentration before it is blown down.

The cooling tower has six main components: (1) the treated wood structure, (2) the 150 hp, 28 ft diameter mechanical draft fans with 14 ft tall fan stacks to direct the airflow, (3) the heat transfer section made up of corrugated PVC sheets commonly called the "fill", (4) the water distribution system, (5) the drift eliminator section and (6) the concrete basin which collects water for return to the condensers and auxiliaries.

The wood structure is laid out in the cold water basin with 4 in. by 4 in. columns laid out on a 6 ft transverse by 6 ft longitudinal grid. The horizontal girts are located 6 ft or 8 ft vertically from each other and composed of 2 in. by 4 in. or 2 in. by 6 in. wood members. The wood structure is composed of CCA (copper chromate acid) treated Dense No. 1 Douglas Fir members which are held together with 304 stainless hardware. The fan deck is composed of 1 in. thick treated plywood.

Each of the Marley induced draft fans are 28 ft diameter with 7 blades, and pull 1,097,174 cubic feet per minute (cfm) of air through each cell. The fiberglass fan stacks are 14 ft tall and slightly curved to provide velocity recovery of the air flow after passing through the fans. The fan stacks discharge exhaust vapor at a high elevation which minimizes the hazard of fogging.

The heat transfer section of the cooling tower consists of corrugated PVC sheets bonded together to form modules known as film fill packs. The thin PVC film fill sheets are bonded together with glue and have a before-formed-thickness of 0.020 in. and an after-formed-thickness of 0.017 in. The fill packs are 3 ft deep and there are two layers for a combined thickness of 6 ft. The fill packs are bottom-supported on the treated wood structure horizontal girts. Air seals are provided along the perimeter of each cell to prevent air from bypassing the film fill packs. The film fill packs are also cut so they fit close to the columns to prevent air from

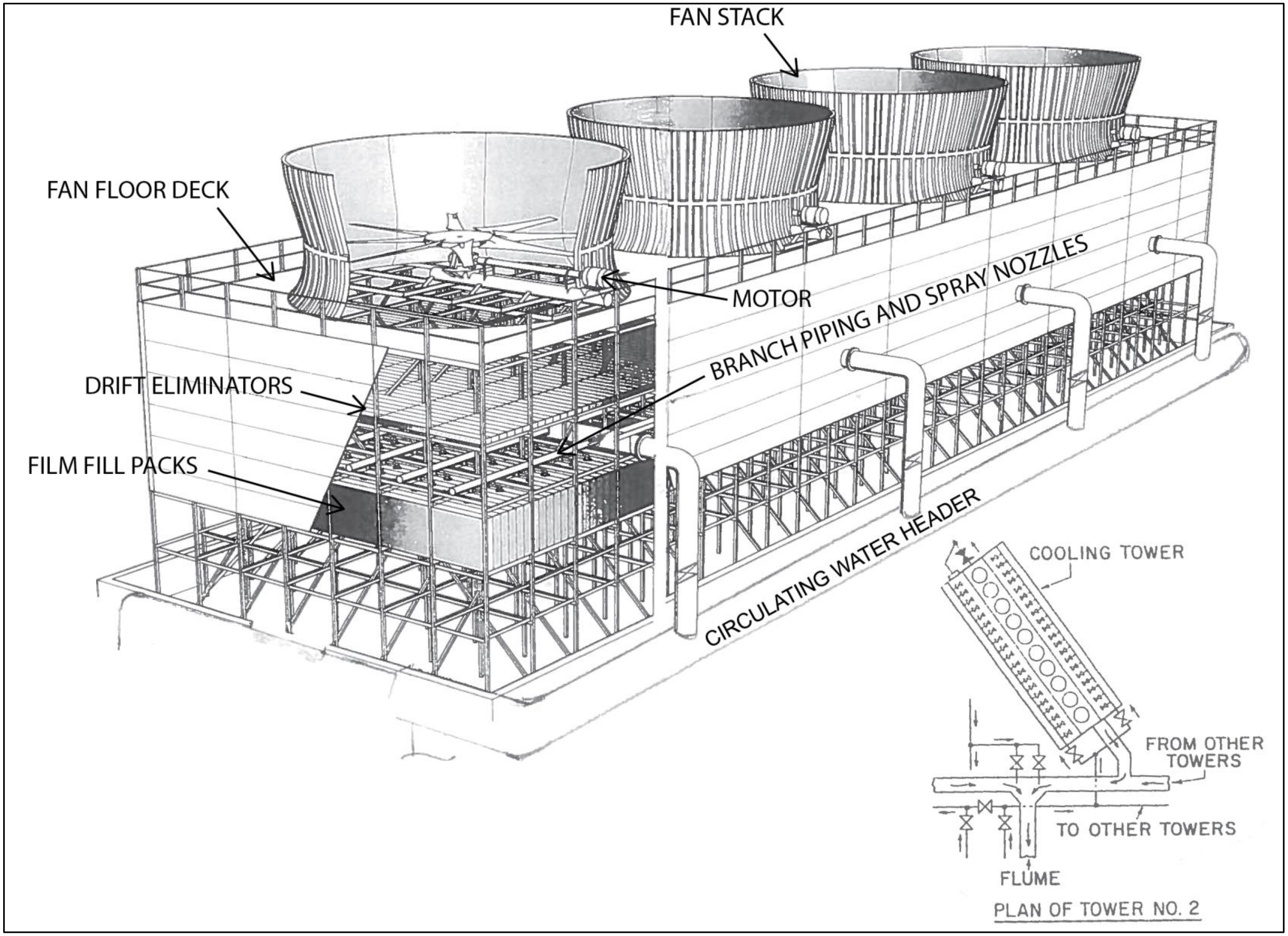

Figure 5-2. Schematic of Clinch River Plant Cooling Tower

bypassing the fill packs.

At each tower, two 36 in. diameter steel pipe stubs exit the ground and combine into a 48 in. diameter fiberglass header pipe which runs on one side of the tower. A 24 in. diameter fiberglass riser supplies water to each cell and branches into eight 6 in. diameter PVC distribution pipes (or branch arms). There are 388 down spray nozzles (28 GPM/nozzle) in each cell which are laid out in a 3 ft by 2 ft pattern above the film fill to equally distribute the warm circulating water to all sections of the tower fill. The water flows through the nozzles and strikes the splash plates, producing “umbrella like” sprays over the fill modules below. The spray cascades down the corrugated module sheets as a thin film and falls into the cold water basin. Air-water contact is established as the ambient air rises upward through the fill.

Marley TU12 cellular PVC drift eliminator panels, 0.017 in. thick, are provided which have an efficiency of 0.005%. The 5-3/4 in. thick drift eliminator panels are supported off of the distribution piping. These panels are designed to reduce the amount of water entrained in the rising air that leaves the tower shell as drift by abruptly changing the direction of the airflow.

The cold-water, concrete, collecting basin has a capacity sufficient to provide a water storage reservoir and accommodate the falling water in the tower and the water in the riser pipes at the time of shutoff. The cold water is discharged from each tower collecting basin into flumes 5 ft wide by 6 ft deep, which in turn, widens into a 13 ft wide by 8 ft deep flume. Makeup water supply is automatically adjusted to maintain a normal water level of 2 in. to 7 in. above the top of the concrete pilasters supporting the outer walls of the tower. Normal basin water level is 1,512 ft. Maximum overflow level is 1,512 ft-8 in. with overflow commencing at 1,512 ft-3 in. Overflow is collected in a 4 ft by 19 in. box at the northeast end of the tower.

A cooling tower center-line trough, 2 ft wide by 8 in. deep, runs along the bottom length of each basin and is sloped downward in a northeast direction for drainage purposes. On Tower No. 4 only, this trough is discharged through a manual valve and motor operated valve to sump 003 and them pumped to the advanced waste water treatment plant for treatment.

The controls for each cooling tower are located in 2 cooling-tower control houses. Control House 12 controlling Towers 1 and 2 is located between these 2 towers. Control House 34 controlling Towers 3 and 4 is similarly located. The control panel for each cooling tower contains five 3-position fan switches and indicating lamps.

Freezing will not occur in the flooded portions of a tower, only in the relatively dry parts where fine drops of water splash out into the entering air stream. This can happen whenever the wet-bulb temperature is below freezing, regardless of the dry-bulb temperature. The ice will form on the structural framing, and on the outer filling. The ice starts to form near the bottom of the film fill and along the transverse structural framing, building inward and upward. The formation of ice restricts the flow of air and reduces the performance, causing a rise in the temperature of the water leaving the tower. Various operating procedures are used to minimize freezing, or to remove ice once it has formed. The ice may be melted by utilizing the heat in either the exhaust air or in the water that is being circulated over the tower. The method of doing this is air entering the lower level of film fill panels will cause ice to form along the lower perimeter of fill. Stopping the fans temporarily allows the water to fall vertically and melt ice that has formed along the perimeter. This will remove ice from the filling and part of the structure.

5.2 Design and Engineering Calculations [§122.21(r)(5)(ii)]

The design and engineering calculations and supporting data that provide the basis of Section 5.1 were prepared and reviewed by AEP using a qualified professional. Engineering calculations of the through-screen velocity prepared by an AEP and reviewed by an HDR qualified professional are provided in Appendix B.

5.3 Description of Existing I & E Reduction Measures [§122.21(r)(5)(iii)]

The primary reduction in both impingement and entrainment at the Clinch River Plant is achieved through the use of a closed-cycle cooling system. The cooling towers are described in detail in Section 5.1. The cooling towers are presently operating at two-to-five cycles of concentration (COC) and provide at least 97.0% flow reduction (using two COC) as compared to a once-through cooling system (see Section 6.1 for calculations of makeup water minimization).

The closed-cycle cooling system meets Compliance Alternative 1 (§125.94(c)(1)) for impingement mortality reduction in the final Rule. Assuming that the reduction in entrainment is commensurate with reduction in flow, then, the closed-cycle cooling system would reduce entrainment by at least 97.0% compared to a once-through system. Closed-cycle cooling alone should be sufficient to minimize adverse environmental impacts associated with CWIS operation. However, there are additional features at Clinch River Plant that further reduce impingement and entrainment.

Since Unit 3 is now retired, the design through-screen velocity is estimated to be 0.5 fps and 0.2 fps at low water level of 4 ft and a normal pool level of 14 ft, respectively. A maximum design through-screen velocity of 0.5 fps meets the impingement mortality reduction standard through Compliance Alternative 2 (§125.94(c)(2)).

Water withdrawals for the cooling water system are further minimized by operating at higher cycles of concentration, which will increase to five in late 2016 with conversion from coal to natural gas.

In addition, Clinch River Plant has a favorable orientation of the intake in terms of potential reduction in impingement and entrainment because of (1) perpendicular orientation of intake to river current such that passive organisms would tend to be carried past the intake and (2) intake location in the midsection of a long pool, which physically isolates it from the majority of fish and mussel species that tend to inhabit riffle/run habitat (in particular the T&E species).

Furthermore, Clinch River Plant is a fairly isolated area, so that no nearby alternative water sources (e.g., reclaimed wastewater, grey water) are available. Groundwater and public water supply resources are inadequate to provide an alternative cooling water source for this facility.

6 Chosen Method(s) of Compliance with Impingement Mortality Standard [§122.21(r)(6)]

Clinch River Plant utilizes a closed-cycle cooling system and the flow reduction achieved relative to once-through cooling (OTC) is estimated to be 97.0% to 98.1% with current operation that has two-to-five COC. See Section 6.1 below for the calculation of makeup water minimization. A closed-cycle cooling system meets Compliance Alternative 1 for impingement mortality reduction in the final rule (§125.94(c)(1)). Assuming that the reduction in entrainment is commensurate with reduction in flow, then the closed-cycle cooling system also reduces entrainment by at least 97.0% (assuming that the tower is operated at only two COC) compared to a once-through system. Closed-cycle cooling alone should be sufficient to minimize adverse environmental impacts associated with CWIS operation and provides the strongest basis for the cooling system to be determined to be BTA for both impingement and entrainment. Additionally, the Clinch River CWIS is compliant with a separate, fully sufficient, approach to impingement BTA under §125.94(c)(2) as the maximum design intake through-screen velocity is 0.5 fps.

AEP neither has site-specific data to support *de minimis* rate of impingement (§125.94(c)(11)), nor requests BTA determination based on low capacity utilization (§125.94(c)(12)) because of its base-load generating units with high capacity utilization. In summary, AEP proposes that the existing intake structure and cooling water system are BTA under the final rule and that no additional measures are necessary or appropriate.

6.1 Requirements of Makeup Water Minimization for Closed-cycle Recirculating System

A closed-cycle recirculating system withdraws significantly less water from its source water body than a once-through cooling system. The actual reduction in withdrawal quantities depends on how the recirculating cooling system is designed and operated. Table 6-1 presents the site-specific design and operation parameters of the closed-cycle cooling system at the Clinch River Plant.

The cooling towers installed at the Clinch River Plant are currently operating at two-to-five COC and providing a reduction in flow of at least 97.0% (using two COC) relative to a OTC. However, as a result of planned operational changes (which are conversions of Units 1 and 2 from coal to gas as described in Section 5.1) that will decrease makeup water flow, AEP Clinch River Plant plans to begin operating the cooling towers at five COC in late 2016. This will result in a flow reduction of 98.1% as compared to OTC. Makeup flow calculations are provided below.

Table 6-1. Site-Specific Design and Operation Parameters of Closed-Cycle Cooling System at Clinch River Plant

Design and Operational Parameters	Values
Condenser Cooling Water Flow and Condenser Temperature Rise (i.e., delta T)	Each of the four cooling towers for Units 1 and 2 is designed to cool 55,000 GPM of water from 97°F to 78°F (temperature range of 19°F) which would encompass the condensers and all the misc. exchangers.
Cycles of Concentration (COC) at which the cooling tower is typically operated	The circulation water system is currently operated at 2 to 5 Cycles of Concentration, and it will be changed to 5 cycles by late 2016 after conversion from coal to natural gas.
Drift Eliminator Efficiency (from the Cooling Tower Specification	0.005%
MW rating of generating units	The current MW rating of Units 1 to 2 is 235 MW each Unit and the unit capacity is expected to increase from 235 MW to 237 MW after the gas conversion.

Evaporation, drift and blowdown rates are calculated and summed as the makeup flow:

Makeup flow = **Evaporation** + **Drift** + **Blowdown**

where:

Evaporation, E = 0.0008 x Condenser temperature delta T(°F) x Condenser cooling water flow rate (GPM)

Drift, D = Drift eliminator efficiency x Condenser cooling water flow (GPM)

Blowdown, B = [E-{(COC-1) x D}]/(COC-1)

Then, the makeup flow is compared with condenser cooling water flow (i.e., once-through flow) to determine the degree of flow reduction.

Using the cooling tower flow of 55,000 GPM, delta T of 19 °F, drift eliminator efficiency of 0.005% and 2 COC, the example calculations for evaporation, drift and blowdown rates are as follows:

E = 0.0008 x 19 °F x 55,000 GPM = 836 GPM

D = 0.00005 x 55,000 GPM = 3 GPM

B = [836 GPM – {(2-1) x 3 GPM}]/(2-1) = 833 GPM

Makeup Flow for 2 COC = 836 GPM + 3 GPM + 833 GPM = 1,672 GPM

Therefore, the calculated makeup water flows for two COC and five COC are 1,672 GPM and 1,045 GPM per cooling tower, respectively. As a result, the percent flow reductions compared to a once-through cooling system are 97.0% and 98.1% for two and five COC, respectively.

AEP believes that at five COC, the makeup water flow to the towers will have been minimized to the maximum extent possible within the constraints of practicality, scaling and other operational issues, and the need to comply with discharge concentration limits on cooling tower blowdown.

7 Entrainment Performance Studies [§122.21(r)(7)]

There have been neither site-specific entrainment performance studies conducted at Clinch River Plant, nor relevant studies from other facilities.

8 Operational Status [§122.21(r)(8)]

8.1 Description of Operating Status [§122.21(r)(8)(i)-(8)(v)]

The Clinch River Plant currently consists of two units. Units 1 and 2 both came into service in 1958, and each is currently rated at 235 MW capacity. Unit 3 rated at 235 MW came on-line in 1961 and is now retired. Cooling water at this plant is used only for power production. Utilization over the previous seven years is provided in Table 3-1 in Section 3.3. The major changes to the system in the last fifteen years have been the replacement of all five cooling towers during the years 1999-2002 and retirement of Unit 3. Planned changes over the next five years include:

- Conversion of Unit 1 from coal to natural gas by December 2015, and similar conversion of Unit 2 by May 2016. This conversion will result in an increase in rated capacity of each unit from 235 to 237 MW, and decrease in heat rate from an average of 11,232 btu/kwh per unit (2011-2012 average) to an expected 10,051 btu/kwh per unit following the conversion.

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Appendix A

11” x 17” Engineering Drawings of River Water Make-Up Intake Structures:

- Drawing No.13-5024-15: Clinch River Plant Plot Plan
- Drawing No.12-5112-7: Screen House Arrangement, Make Up, Screen Wash and Drainage Piping (Unit 1 and 2)

DWG. NO. 13-5024-15

NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.
7/?/09	15	PER SNCR PROJECT: ADDED DAY TANKS, BULK STORAGE, & RAIL UNLOADING. PER HYDROGEN RELOCATION: ADDED BULK HYDROGEN STORAGE & DELIVERY FACILITY (H4)	
6/2/00	14	PER AS BUILT CONDITIONS: ADDED WASTEWATER TREATMENT BUILDING, TANKS AND ROADS. ADDED FLY ASH CONTROL BLD'G. AND SCALE HSE. DR	
5/23/94	13	THIS DRAWING & DRAWING 13-5024A SUPERSEDES DRAWING 123-5024. ADDED COPPER RED. FAC. @ E/4. REMOVED OIL TANK @ K/6 AND GENERAL UPDATE OF DESCRIPTIONS. NF/AFS	
		THIS DRAWING HAS BEEN ELECTRONICALLY SCANNED SEE MICROFILM RECORDS FOR HISTORY & SIGNATURES DRAWING REVISION 11	

REVISIONS

s: /cr/13/mech_arrgt/5024.dgn

APPALACHIAN POWER Co.

CLINCH RIVER PLANT

CARBO VIRGINIA

PLOT PLAN

DWG. NO. 13-5024-15

ENGINEERING DIVISION S.M. FIALA

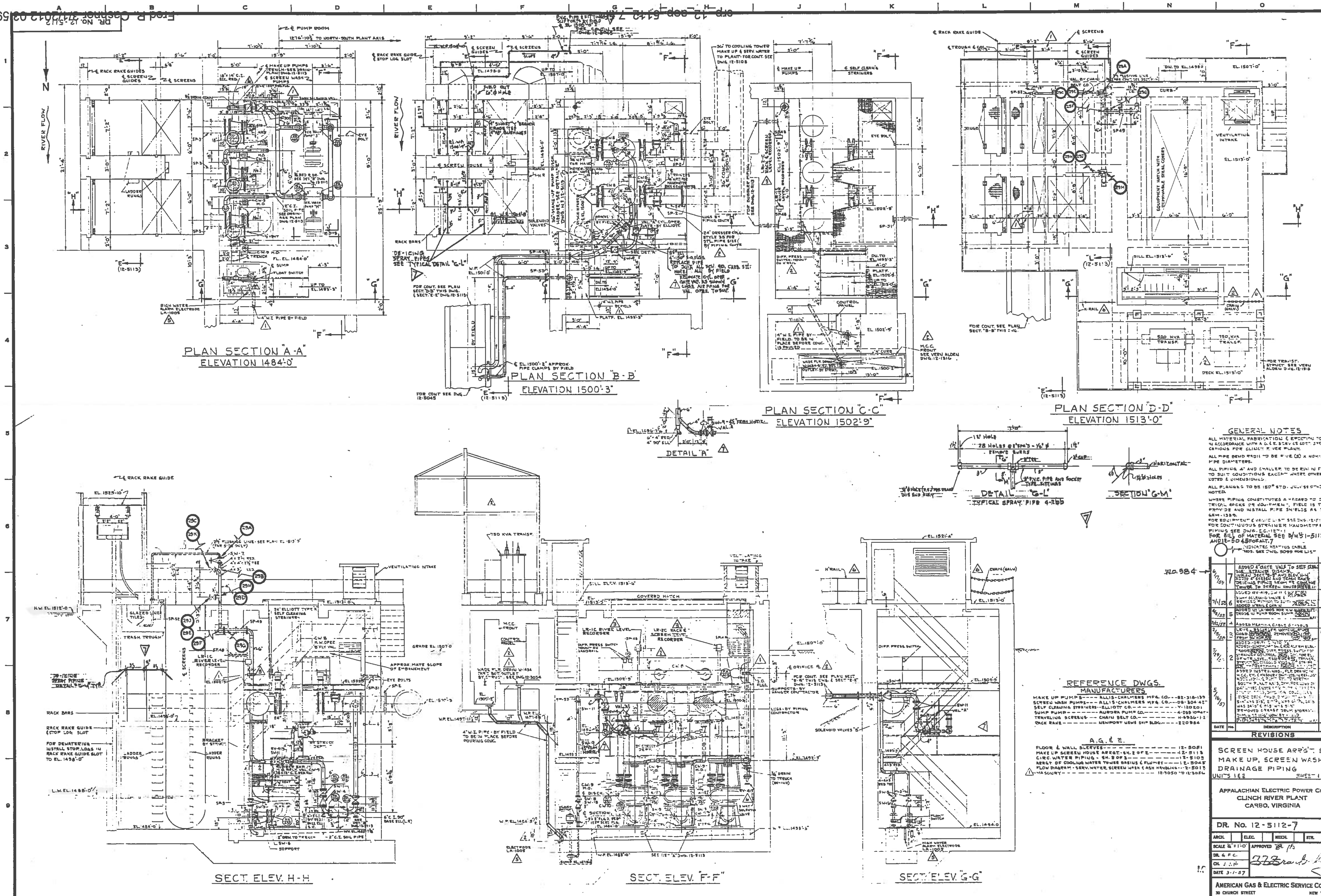
DESIGN DEPARTMENT

AMERICAN ELECTRIC POWER

1 RIVERSIDE PLAZA COLUMBUS, OH 43215

SYSTEM DATE-7/1/2009

32



PLAN SECTION "A-A"
ELEVATION 1484'-0"
PLAN SECTION "B-B"
ELEVATION 1500'-3"
PLAN SECTION "C-C"
ELEVATION 1502'-9"
PLAN SECTION "D-D"
ELEVATION 1513'-0"
DETAIL "A"
DETAIL "C-L"
TYPICAL SPRAY PIPE 4-Rbb
SECTION "G-M"
SECT. ELEV. H-H
SECT. ELEV. "F-F"
SECT. ELEV. "G-G"
RIVER FLOW
GENERAL NOTES
ALL MATERIAL FABRICATION & ERECTION TO BE IN ACCORDANCE WITH A.G.&E. SERV. CO. CORP. SPECIFICATIONS FOR CLINCH RIVER PLANT.
ALL PIPE BEND RADII TO BE FIVE (5) x NOMINAL PIPE DIAMETERS.
ALL PIPING 4" AND SMALLER TO BE RUN IN FIELD TO SUIT CONDITIONS EXCEPT WHERE OTHERWISE NOTED & DIMENSIONED.
ALL FLANGES TO BE 150# STD. UNLESS OTHERWISE NOTED.
WHERE PIPING CONSTITUTES A HAZARD TO ELECTRICAL RACKS OR EQUIPMENT, FIELD IS TO PROVIDE AND INSTALL PIPE SHIELDS AS PER GEM-1389.
FOR EQUIPMENT & VALVE LIST SEE DWG. 12-5112
FOR CONTINUOUS STRAINER MANOMETER PIPING SEE DWG. EC-1277-1
FOR BILL OF MATERIAL SEE B/M 51-5112 AND 12-5045 FOR ALT. 7
INDICATES HEATING CABLE NOS. SEE DWG. 5099 FOR LIST
REFERENCE DWGS.
MANUFACTURERS
MAKE UP PUMPS---- ALLIS-CHALMERS MFG. CO.---82-318-139
SCREEN WASH PUMPS--- ALLIS-CHALMERS MFG. CO.---08-304-43
SELF CLEANING STRAINERS--ELLIOTT CO.---Y-120201
SUMP PUMP--- AURORA PUMP CO.---4-059 10945
TRAVELING SCREENS--- CHAIN BELT CO.---H-6936-12
RACK RAKE--- NEWPORT NEWS SHIP BLDG.---220984
A.G.& E.
FLOOR & WALL SLEEVES---12-5081
MAKE UP SCREEN HOUSE ARRGT.-SH. 2 OF 2---12-5113
CIRC. WATER PIPING - SH. 2 OF 3---12-5109
ARRGT. OF COOLING WATER TOWER BASINS & FLUMES---12-5045
FLOW DIAGRAM - SERV. WATER, SCREEN WASH & ASH HANDLING---2-5013
MASONRY---12-5050 TO 12-5056
W.O. 584
REVISIONS
SCREEN HOUSE ARR'G'T. & MAKE UP, SCREEN WASH & DRAINAGE PIPING
UNITS 1 & 2 SHEET 1 OF 2
APPALACHIAN ELECTRIC POWER CO.
CLINCH RIVER PLANT
CARBO, VIRGINIA
DR. No. 12-5112-7
SCALE 1/4"=1'-0"
DATE 3-1-57
AMERICAN GAS & ELECTRIC SERVICE CORP.
30 CHURCH STREET NEW YORK
33

Appendix B

Engineering Calculations of Through-Screen Velocity for Traveling Screen Design

Prepared By:	Date
Bob Cashner, PE American Electric Power Lead Engineer	August 12, 2014

Reviewed By:	Date
Radhika de Silva, PhD, PE HDR Engineering, Inc. Senior Project Manager	February 26, 2015

Approved By:	Date
John Burnett HDR Engineering, Inc. Senior Environmental Scientist	February 26, 2015

Calculation Purpose:

Calculate the through-slot velocity at the traveling screens under the design capacity of the screen.

System Description:

The intake structure has two 7 ft-2 in. wide intake openings and contains two conventional traveling water screens (TWS) with each basket frame measuring 6 ft wide by 2 ft high and 3/8-inch square mesh openings. It is assumed that the screen mesh dimensions (where water flows through) for each basket are 71 in. wide by 21 in. high (i.e., 10.3 ft^2). US Filter has provided a percent open area (POA) of 67.9 for a screen with 3/8-in. square openings and #14 (0.080 in. diameter) mesh wire. The bottom of the screens are located at elevation 1,484 ft, compared to a low water level of 1,488 ft, and normal pool level of 1,498 ft.

Calculation Methodology:

For the design and configuration of the Clinch River Plant CWIS, assuming a low water level of 4 ft (or two 2 ft tall baskets submerged) and 1 pump operation (6,500 GPM, or 9.36 MGD), the calculated through-screen velocity[4] at low water level is:

v = (6,500 gal/min) x (1 min/60 sec) x (0.1337 ft^3/gal) x (1/2 TWS) x (basket/10.3 ft^2) x (TWS/2 baskets) x (1/0.679 POA)

v = 0.52 ft/sec

Similarly, the following calculation shows the through-screen velocity using a normal pool level of 14 ft. For the design and configuration of the Clinch River Plant CWIS, with a normal pool level of 14 ft (or seven 2 ft tall baskets submerged) and 1 pump operation (6,500 GPM), the calculated through-screen velocity[4] is:

v = (6,500 gal/min) x (1 min/60 sec) x (0.1337 ft^3/gal) x (1/2 TWS) x (basket/10.3 ft^2) x (TWS/7 baskets) x (1/0.679 POA)

v = 0.15 ft/sec

[4] Calculated values were rounded to tenths for use within the body of the Clinch River Plan Clean Water Act §316(b) Compliance Submittal Requirements report.